ASSESSMENT OF GROUND-WATER MONITORING REQUIREMENTS ALONG THE NORTHWEST FLORIDA COAST

NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Water Resources Special Report 86-1

January 1986

ASSESSMENT OF
GROUND-WATER MONITORING REQUIREMENTS
ALONG THE
NORTHWEST FLORIDA COAST

By Linda Ann Clemens

NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Water Resources Special Report 86-1

January 1986

NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT

GOVERNING BOARD

For additional information, write or call:

Northwest Florida Water Management District
Route 1, Box 3100
Havana, Florida 32333
(904) 487-1770

TABLE OF CONTENTS

TABLE OF CONTENTS - (continued)

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

The major ground-water quality concern along the coastal areas of the Northwest Florida Water Management District is contamination by salt water, due to either upconing or lateral intrusion caused by overpumping of ground water. Past problems in at least two coastal cities, Panama City and Port St. Joe demonstrate the fragile nature of the coastal ground-water setting and the potential for contamination due to overpumping. Although saltwater intrusion is not currently a major problem in the Northwest District, some areas are beginning to experience difficulties as increasing development along the coast creates a greater demand for water. The goals of this project are: 1) to evaluate the current position of the saltwater interface along the coastal area of the Northwest District; and 2) to design a long-term ground-water monitoring network to be used to monitor future changes in the position of the saltwater interface. This project concentrated on design of a monitoring system for the Floridan Aquifer, the major source of ground-water supply in the coastal areas of the Northwest District.

Water quality in the Floridan Aquifer varies widely due to both natural and man-made factors. In general, the water in the Floridan Aquifer becomes increasingly saline toward the west, as the aquifer dips more deeply below the land surface. Localized areas of poorer quality water are found in the Choctawhatchee Bay area in southern Okaloosa and Walton counties, in the stretch of coast between Mexico Beach in Bay County and Cape San Blas in Gulf County, along the Apalachicola River in Franklin and Gulf counties and in the Spring Creek area of Wakulla County. Areas where saltwater contamination has

occurred because of ground-water withdrawals include the Panacea area in Wakulla County, Panama City Beach and Tyndall Air Force Base in coastal Bay County and the Fort Walton Beach and Destin area in Okaloosa County, which appears to show a low-level increase in chloride concentration when compared to surrounding areas.

A monitoring network of 65 wells is proposed to monitor potential saltwater movement in the coastal areas of Northwest Florida. The construction of 56 new wells is recommended, along with the use of nine existing wells. Proposed monitoring well depths range between 75 feet and 1200 feet and at least one monitoring well is proposed for each coastal county. A two step sampling program is proposed, with an initial comprehensive analysis of several water quality parameters to be followed with a long-term sampling and analysis program utilizing a limited number of indicator parameters.

INTRODUCTION

In October 1984, the Northwest Florida Water Management District (NWFWMD) began work on an evaluation of ground-water monitoring requirements in the coastal area of northwest Florida. The main monitoring concern along the coastline is contamination by salt water, due to either upconing or lateral intrusion caused by over-pumping of ground water. Past problems in at least two coastal cities, Panama City and Port St. Joe demonstrate the fragile nature of the coastal ground-water setting and the potential for contamination due to overpumping. Although saltwater intrusion is not currently a major problem in the Northwest District, some areas are beginning to experience difficulties as increasing development along the coastline creates a greater demand for water. Certain areas of the District, because of their limited water resources, are more vulnerable to saltwater intrusion or upconing due to over-pumping caused by this increased demand.

The goal of this project is the creation of a monitoring plan which will: 1) identify the current position of the freshwater/saltwater interface; 2) provide for monitoring inland migration of the interface; and 3) assist in establishing minimum and management levels in areas where ground-water withdrawals are significant. The area covered by this project is shown in Figure 1. It is anticipated that the data produced by the implementation of this plan will provide valuable input into the NWFWMD Consumptive Use Permitting Program and will contribute to on-going water quality management planning efforts under the Water Quality Assurance Act. The plan is intended to be implemented jointly by NWFWMD and the U. S. Corps of Engineers.

This report summarizes the results of the coastal area study. Principal tasks included:

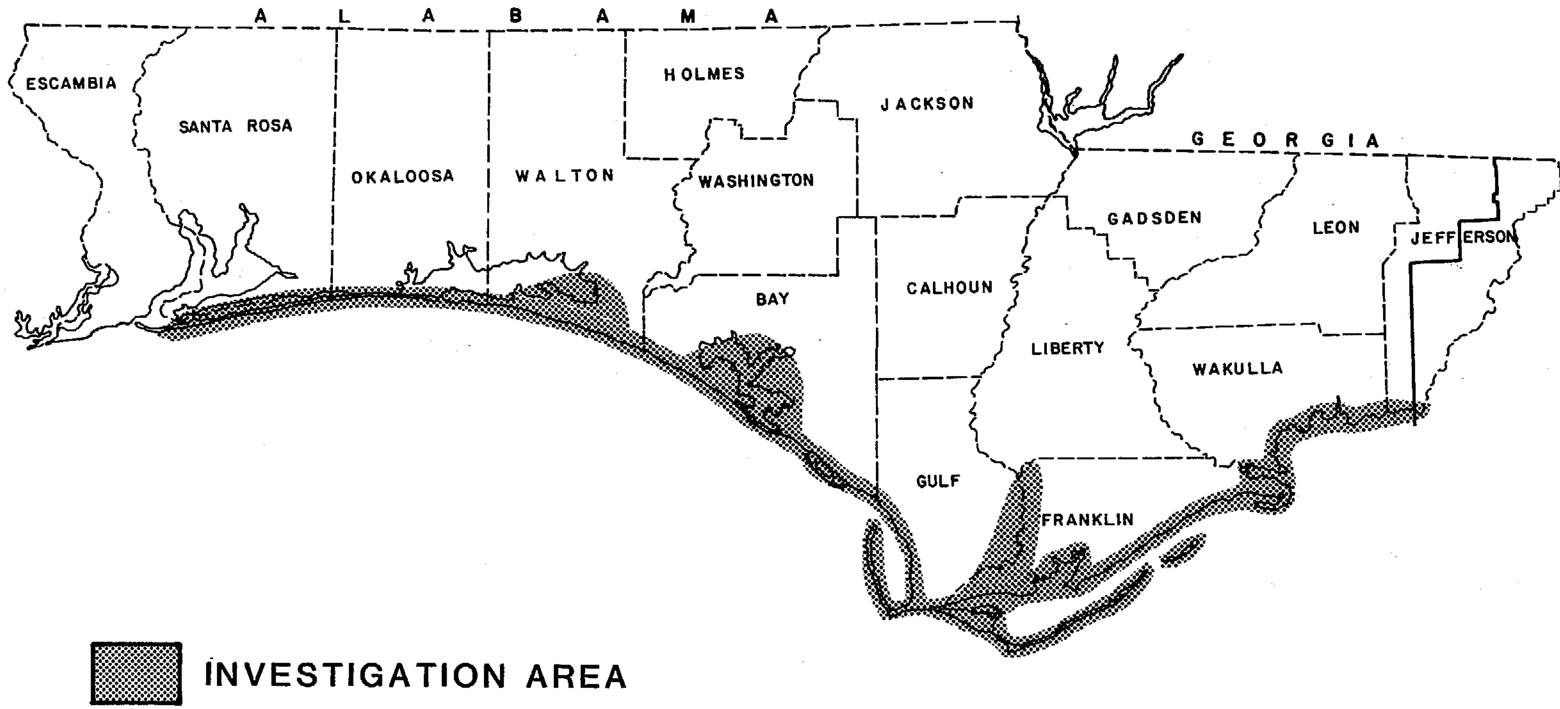


FIGURE 1- LOCATION OF AREA OF INVESTIGATION

- Review of published geologic and hydrologic reports for coastal areas of the region and water quality and other pertinent data on file at the Northwest Florida Water Management District, U. S. Geological Survey (USGS), Florida Bureau of Geology (BOG), and the Florida Department of Environmental Regulation (DER). Boring logs, driller's completion reports and geophysical logs for water wells in the coastal area were compiled and reviewed.

- Construction of regional cross sections showing chloride concentrations versus depth in existing wells along the coastline.

- Identification of zones of high and low permeability within the ground-water systems.

- Identification of principal pumping centers in the coastal areas, including maps of current cones of depression and data on historical cones of depression and saltwater intrusion.

- Identification of areas where additional monitoring is required to better define the movement and position of the saltwater/freshwater interface.

- Preparation of a comprehensive monitoring plan of the monitoring needs of the coastal areas. The plan includes location and construction details of each proposed well.

Previous Work

No comprehensive study of saltwater intrusion along the entire coast of the Northwest District has been conducted prior to this project. The Ambient Ground-Water Monitoring Program conducted by NWFWMD for DER contained in its Phase I report (Wagner and others, 1984) a map of the saltwater/freshwater interface along the District coastline. Data used in construction of that map is included in this report and provided an initial point for data collection.

Florida Bureau of Geology reports, some of which surveyed the county ground-water resources, covered Jefferson County (Yon, 1966), Escambia and Santa Rosa counties (Musgrove and others, 1965a; Marsh, 1966), Okaloosa County (Clark and Schmidt, 1982), Walton County (Pascale, 1974) and Bay County (Schmidt and Clark, 1980; Musgrove, and others, 1965b; Foster, 1972). The U. S. Geological Survey has conducted several ground-water investigations in the Northwest District coastal area, including the Pensacola/Escambia County area (Trapp, 1975; Trapp, 1972; Coffin, 1982) and the Okaloosa, Walton and Santa Rosa county area (Trapp and others, 1977, Wagner, and others, 1980b; Hayes and Barr, 1983; Barr and others, 1985). The Northwest Florida Water Management District has completed three ground-water studies in the coastal area: Barr and others, 1981, which covers the water resources of southern Okaloosa and Walton counties, Barr and Wagner, 1981, which surveys the water resources of southwestern Bay County and Pratt and Barr, 1982, which covers the sand-and-gravel aquifer in southern Santa Rosa County. Another study currently in final stages covers ground-water quality and availability in the area between Destin in Okaloosa County and the Bay County/Walton County line.

Other, more general reports covering the area include Puri, 1954, Chen, 1965; Kwader and Schmidt, 1978; Wagner and others, 1985; Schmidt, 1983; Wagner, 1983, and Wagner, and others, 1980a.

Areas of the Northwest District coastline which are not adequately covered by existing reports include Jefferson, Wakulla, Franklin and Gulf counties. This part of the District is still relatively sparsely populated and contains large tracts of National Forest, swamp and marsh land, National Wildlife Refuge and planted pine forest without appreciable water well coverage. The coastal Ochlockonee River area is covered by Pascale and Wagner, 1982. Trapp, 1977, reported records of a deep potable water exploration well drilled in coastal Franklin County, while Cole (1945) has records of two oil test wells in Wakulla and Jefferson counties. A District study of Wakulla, Jefferson and Leon counties is currently ongoing.

Other information used in this report comes from the NWFWMD well permitting files, USGS well completion reports and Florida BOG lithologic logs. Information on water use was supplied by the NWFWMD consumptive use permitting program by Kranzer (1983) and by the water use subtask of the Ambient Monitoring Program Phase I report prepared by NWFWMD for DER (Wagner and others, 1985). The Ambient report also supplied information on saltwater intrusion and District hydrogeology.

Much of the water quality data available for the coast was collected during miscellaneous water resources studies through the years. A majority of the data was collected by the USGS, which maintains a computerized data file of water quality information. Other information was collected by NWFWMD, especially in southern Okaloosa and Walton counties. Some water quality information was supplied by DER Drinking Water Program records.

Figure 2 shows locations of the wells used to provide data for this report. Appendix A lists the wells by name and site identification number. Also given are well depths and casing depths related to mean sea level as well as the altitude of each well site.

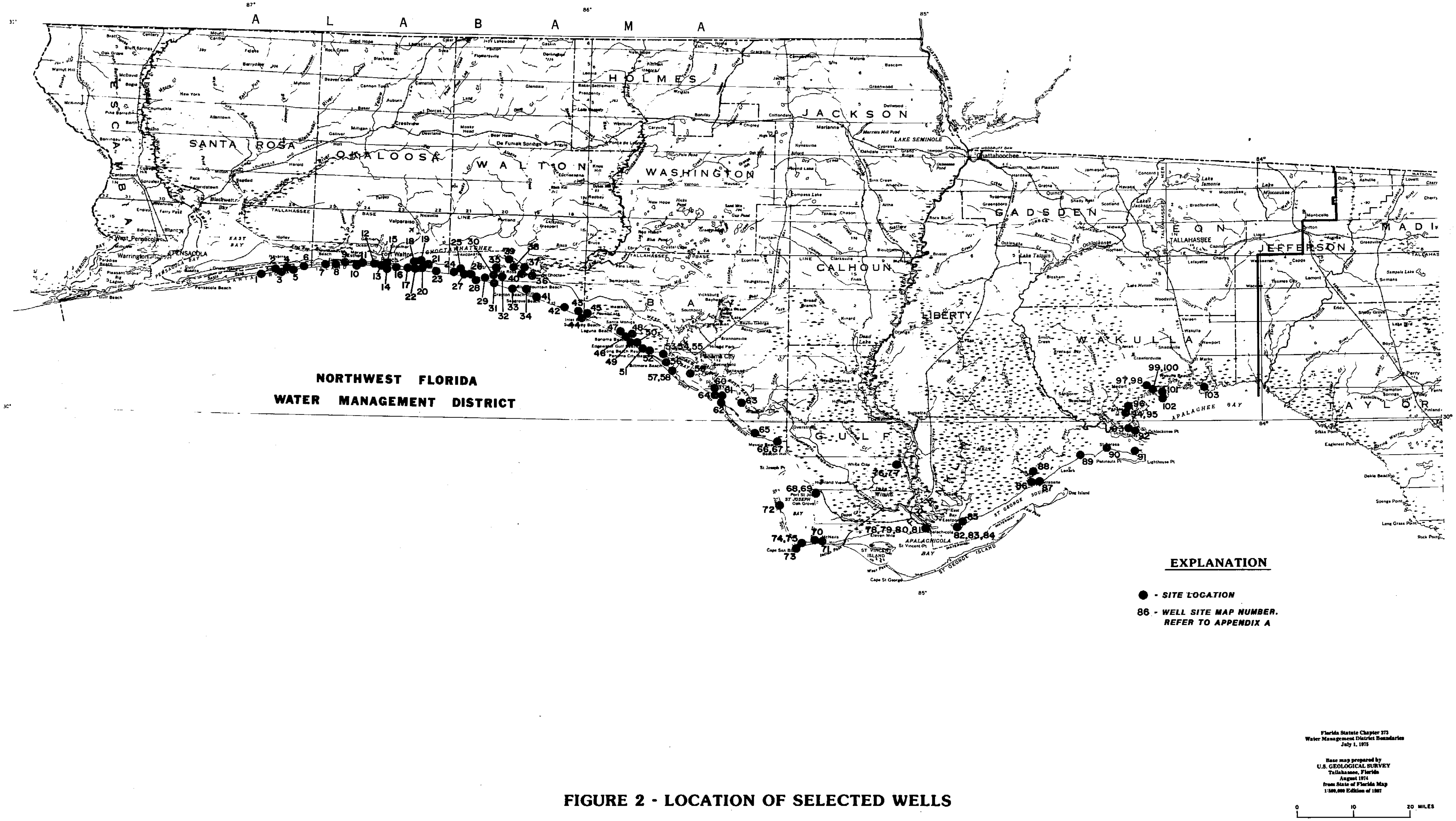


FIGURE 2 - LOCATION OF SELECTED WELLS

WATER USE IN THE NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT

In general, ground-water pumpage in the Northwest District is concentrated in urban areas and along those portions of the coastline which have been fairly extensively developed. Major coastal ground-water users are concentrated around Pensacola (Escambia County) and Navarre Beach (Santa Rosa County), in the vicinity of Fort Walton Beach and Destin (Okaloosa County) where several major public water supply systems pump from the Floridan Aquifer, and in the vicinity of Panama City (Bay County). In addition, development is occurring at a rapid rate along coastal Okaloosa and Walton counties and the Cape San Blas area of Gulf County.

Ground-water pumpage along the Gulf of Mexico has resulted in water-level declines in several areas along the Gulf of Mexico coast in northwest Florida. The most severe declines in the Floridan Aquifer water level are found in the vicinity of Ft. Walton Beach where a regional extensive cone of depression has developed in recent years. Panama City and Port St. Joe are areas where cones of depression have developed in the recent past, but conditions have returned to normal due to changes in sources for water.

Saltwater intrusion due to pumping has been documented near Panacea in Wakulla County (Pascale and Wagner, 1982). Available data also indicates localized lateral intrusion or upconing of salt water at Panama City Beach in Bay County and possibly in coastal Okaloosa County. In some areas of the District, water of poorer quality occurs naturally within the Floridan Aquifer, causing potential problems for adjacent users and overlying water-bearing formations. These areas include south Walton County, areas west of Navarre Beach in Santa Rosa County, the area between Mexico Beach in Bay

County and Cape San Blas in Gulf County, the Spring Creek/Shell Point area in Wakulla County and possibly the Apalachicola River basin in Franklin County.

Major Water Users

Major water users along the coastal areas of the Northwest District were identified through the NWFWMD Consumptive Use Permitting Program. Information on those facilities which have not yet applied for consumptive use permits was supplied by Kranzer (1983). For the purposes of this project, major water users are defined as those facilities in coastal areas which use more than 100,000 gallons of water per day.

Appendix B lists major water users by county and shows well locations and permitted average and maximum daily usage. Table 1 provides a summary of ground-water use, by county, as permitted by NWFWMD.

Table 1.--Average and Maximum Daily Use in the Coastal Areas of the Northwest District.

County	Average Use (Mgal/d)	Maximum Use (Mgal/d)
Bay	2.18	4.86
Escambia	82.63	120.67
Franklin	1.02	2.13
Gulf	0.87	1.30
Okaloosa	20.31	42.16
Santa Rosa	16.17	24.61
Wakulla	0.38	0.59
Walton	3.24	5.76
TOTAL	126.80	202.08

Current and Historic Cones of Depression

Fort Walton Beach Area

The Consumptive Use Permitting Program at NWFWMD has identified the Fort Walton Beach/southern Okaloosa County area as an area of special concern because of significant Floridan Aquifer water-level declines. Declines of greater than 240 feet have been recorded along the southern part of Fort Walton Beach and are generally more than 100 feet in the Fort Walton Beach area (Barr and others, 1981). Figure 3 shows the extent of the cone of depression. Available information does not show a widespread increase in chloride concentration in the area, even though the potentiometric surface of the Floridan is now below sea level over a wide area. Trapp and others (1977) attribute this to the low permeability of the Pensacola Clay, which overlies the Floridan throughout the area, and the original location of the saltwater interface, which they estimate to have been several miles offshore. Before development in the area, the potentiometric head of the Floridan Aquifer was as high as 63 feet above sea level at the coastline, with discharge from the Floridan limestones occurring offshore. Trapp and others (1977) assumed that much of the pumpage in the Fort Walton Beach area has intercepted water that would have discharged to the Gulf under natural conditions.

Although no significant saltwater intrusion problems have occurred in the Fort Walton Beach area, the large amount of drawdown that presently exists creates a great potential for problems to arise in the future. Data gathered for this report indicates slightly higher chloride concentration in the Okaloosa Island area as compared to surrounding coastal areas (See Figure 6). Consumptive use permits in this area are now granted for a maximum of five years duration, in order to evaluate the current water usage and effect on the aquifer.

Bay County

From the late 1930's through the mid 1960's, the Panama City area experienced large water-level declines in the Floridan Aquifer. Three major users, the International Paper Company, the Panama City public supply system and Tyndall Air Force Base, pumped large amounts of water from the Floridan Aquifer. By 1962, a sizable cone of depression had formed in the potentiometric surface of the Floridan Aquifer, with water-level declines of 120 to 200 feet (Musgrove and others, 1965b).

Although a sizable cone of depression existed for almost 40 years, saltwater intrusion into the Floridan Aquifer as a result of pumping was not documented. Musgrove and others (1965b) describe saltwater contamination of the Intermediate Aquifer (formerly referred to as the Secondary Artesian Aquifer) in the vicinity of Panama City in their report on the water resources of the Econfina Creek area. Highly saline water from two wells in the aquifer was observed during their field investigations. The saline water was presumed to have leaked through the Surficial Aquifer from nearby bodies of salt water. The underlying Floridan Aquifer did not show any signs of saltwater contamination.

Because of concern that continued pumping would eventually cause water-quality problems, the decision was made to convert to surface water as the main source of supply. Deer Point Lake Reservoir was created, and in January 1964, began supplying water to the three major users. Floridan water levels recovered rapidly when pumpage stopped. Recovery at the center of the cone of

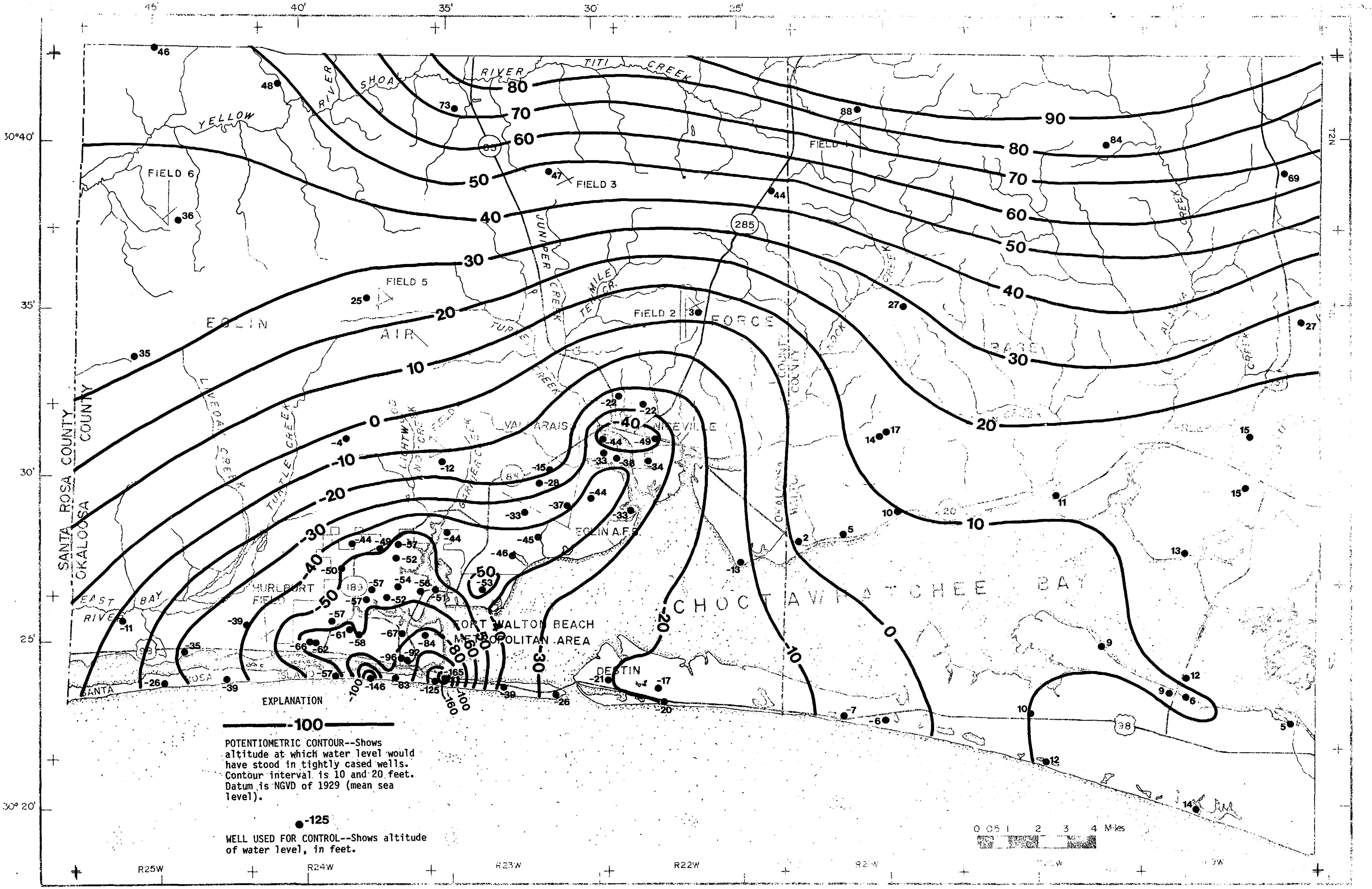


Figure 3 Map showing the potentiometric surface of the upper limestone of the Floridan aquifer in July 1978

depression surrounding the International Paper Company well field was 163 feet within 51 days (Musgrove and others, 1965b).

Port St. Joe

A similar problem with water-level declines developed in the Port St. Joe area in Gulf County during the 1940's (Wagner, written comm.). The major water user, the St. Joe Paper Company, withdrew water from the Floridan Aquifer. By the 1950's, water-level declines were already evident. When expansion created the need to increase the water supply from nine to 30 million gallons per day, a decision was made to develop a surface water supply. A 23-mile long canal was dredged to the Chipola River and is currently used to supply the water needs of the paper company. The only current major use of water from the Floridan Aquifer is the City of Port St. Joe municipal supply, which withdraws about 800,000 gallons per day from a combination of Intermediate and Floridan Aquifer wells. Drawdowns of over 300 feet occur with pumping rates of less than 400 gallons per minute.

HYDROGEOLOGY

Hydrostratigraphy

In the coastal areas of the Northwest District, three to four major water-bearing and up to three confining units may be present. The major aquifers and confining units in the study area are contained in the Middle Eocene to Recent Series, which consists primarily of marine limestones, sand and clay. As many of seven hydrostratigraphic units and as few as four are present in different areas along the coastline. Table 2 shows a generalized stratigraphic column for the coastal area of northwest Florida.

The two major aquifers within the study area are the Surficial Aquifer, referred to as the Sand-and-Gravel Aquifer in the western third of the study area, and the deeper, confined Floridan Aquifer. The Surficial Aquifer is thin and produces limited amounts of water in the eastern part of the study area; however, it thickens considerably to the west and is the primary source of ground-water supply in coastal Escambia County. The Surficial Aquifer is composed of Pleistocene and Recent alluvium and terrace deposits. In the west, the Sand-and-Gravel Aquifer may include permeable portions of the underlying Intermediate System.

The Floridan Aquifer consists of several hundred feet of marine carbonate formations and underlies the entire study area. The top of the Floridan Aquifer is at the land surface in the easternmost part of the study area and dips to over 700 feet below mean sea level in the southeastern Santa Rosa County and over 1450 feet below mean sea level in southern Escambia County (Wagner and others, 1985). Variations in lithology among the carbonate formations comprising the Floridan Aquifer causes variability in their water-bearing properties. Generally, the Miocene age Tampa Stage Formations, which make up the upper portions of the Floridan Aquifer, are finer grained and have a greater clay content, reducing the ability of these formations to transmit water. The Oligocene and Eocene formations, especially the Ocala Limestone, are generally massive, well indurated, fossiliferous limestones, generally with well developed secondary porosity and a greater ability to transmit water.

Three confining units exist in the study area. The Surficial and Floridan aquifers are separated by the Intermediate System confining unit, which varies in lithology. The formations which comprise the Intermediate System consist of sands, gravels, clays and low permeability carbonate materials. The Intermediate System is at its thickest at the westernmost edge of the coastal area and in the Apalachicola Embayment structural depression in Bay, Gulf and western Franklin counties. In parts of the study area, where localized lenses and layers of permeable material are present, an Intermediate aquifer (formerly known as the Secondary Artesian Aquifer) is present within the Intermediate System. In the western part of the study area, the Floridan Aquifer is divided into an upper and a lower limestone by the Bucatunna Clay confining unit. The Bucatunna Clay is absent east of the Okaloosa/Walton County line and the Floridan Aquifer is undifferentiated. The third confining unit is the Sub-Floridan Confining Unit, which consists of low permeability clastics and/or carbonate materials and functions as the underlying confining unit for the Floridan Aquifer.

Further information on stratigraphy and the formations listed in Table 2 can be found in Yon (1966), Musgrove and others (1965a), Clark and Schmidt (1982), Pascale (1974), Schmidt and Clark (1980) and Schmidt (1983).

WEST (Aquifer unit)	WEST (Formation)	SERIES	EAST (Formation)	EAST (Aquifer unit)
Sand-and-Gravel Aquifer	Alluvium and Terrace Deposits	Recent Pleistocene	Alluvium and Terrace Deposits	Surficial Aquifer
Intermediate System	Citronelle Formation	Pliocene	Miccosukee Formation	Intermediate System
Intermediate System Upper Limestone of the Floridan Aquifer	Coarse Clastics Pensacola Clay Intracoastal Formation Bruce Creek Limestone Undifferen-tiated Tampa Stage	Miocene	Hawthorn Formation St. Marks Formation	Intermediate System Floridan Aquifer
Upper Limestone of the Floridan Aquifer Bucatunna Clay Confining Unit	Chattahoochee Formation Chickasawhay Formation Bucatunna Clay	Oligocene	Suwannee Limestone	Floridan Aquifer
Lower Limestone of the Floridan Aquifer Sub Floridan Confining Unit	Ocala Limestone Lisbon Formation Tallahatta Formation Undifferentiated Wilcox Stage	Eocene	Ocala Limestone Undifferentiated Claiborne Stage Undifferentiated Wilcox Stage	Floridan Aquifer
Sub Floridan Confining Unit	Undifferentiated Midway Stage	Paleocene	Undifferentiated Midway Stage	Floridan Aquifer Sub Floridan Confining Unit

TABLE 2- GENERALIZED STRATIGRAPHIC COLUMN FOR THE COASTAL AREAS OF NORTHWEST FLORIDA

Aquifer Characteristics

The physical characteristics of an aquifer control the flow and storage of water within it. These factors are generally obtained by pumping a well at a constant rate and measuring the water-level decline (or drawdown) in a nearby observation well over a specified period of time. The most common characteristics measured in this way are: 1) aquifer transmissivity; and 2) storage coefficient. Aquifer transmissivity is a measurement of the rate at which water flows through the entire thickness of the aquifer. The storage coefficient is a measure of the amount of water released from aquifer storage per unit change in head.

Most of the available aquifer characteristic information in the coastal area was obtained from single well specific capacity tests. In this type of test, the well is pumped at a constant rate and the drawdown measured at the end of a specified time. Ideally, the length of pumping is long enough so that the rate of decline has stabilized. The rate and total water-level decline in the well is dependent upon a number of parameters, including aquifer permeability, aquifer thickness, well diameter, the amount of the aquifer actually penetrated by the well, the amount of well development that took place before pumping, well efficiency and duration of pumping. The result of a specific capacity test is a value which is expressed as a ratio of the discharge of the well, in gallons per minute, to the drawdown in feet in the well at the end of pumping.

It is possible to calculate an estimated transmissivity from specific capacity, however, determination of storage coefficient requires the use of water-level measurements from at least two wells. In the calculation of estimated transmissivity, three other factors must be known besides specific capacity. These are well radius, length of time of pumping and an estimated storage coefficient. The equation relating these factors is (Walton, 1970):

$$\frac{Q}{s} = \frac{T}{264 \log_{10} \left(\frac{Tt}{2693\ rw^2\ S}\right) - 65.5}$$

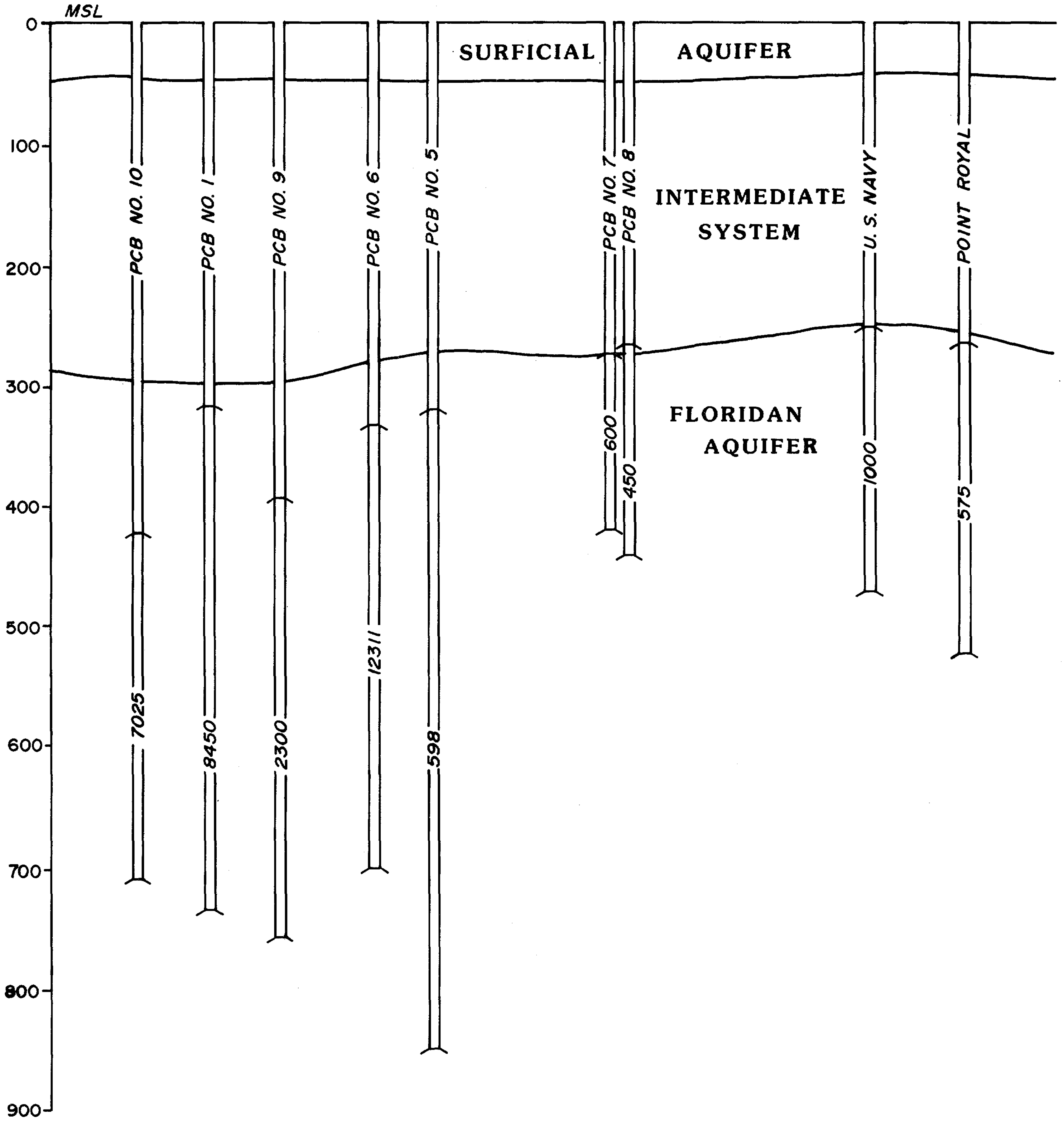
Where: Q = pumping rate of well (gallons/minute)
s = drawdown (feet)
T = transmissivity (gallons/day/foot)
t = time (minutes)
rw = radius of the well (feet)
S = storage coefficient (dimensionless)

Use of this equation produces a value of transmissivity in gallons per day per foot. Transmissivity values were converted by dividing by 7.48 gallons per cubic foot to obtain a final value in feet^2 per day.

This equation assumes that: 1) the pumping well penetrates and is uncased through the entire saturated thickness of the aquifer, 2) well loss is negligible; and 3) the effective radius of the well has not been affected by drilling and development and is equal to the nominal radius of the pumping well (Walton, 1970). This equation also assumes some knowledge of the storage coefficient. However, as Walton (1970) points out, because specific capacity varies with the logarithm of the reciprocal of storage coefficient, large errors in storage coefficient would create relatively small errors in the calculated value of transmissivity. When known from nearby data, measured values of storage coefficient were used. In areas where no data was available, a value of 1×10^{-4} was used for the storage coefficient.

Because of the hydrogeologic variety of the coastal areas of northwest Florida, a great deal of variability was evident in the estimated transmissivities (See Table 3). In general, data was very limited, except in the Santa Rosa, Okaloosa and Walton coastal areas and for parts of Bay County. The major variability through the District appeared to be from area to area rather than with depth. In general, transmissivities in the Upper Limestone of the Floridan Aquifer range from 675 to 12,750 feet squared per day (ft^2/day) in the Navarre Beach area, dropping to between 350 and 1050 ft^2/day on the Eglin Air Force Base property to the east through and including Okaloosa Island service area. Transmissivity values increase in the Destin area to a high of 11,000 ft^2/day in the South Walton County Utilities service area. To the east, values decline to the 500 to 1000 ft^2/day range through Panama City Beach and Tyndall Air Force Base. Tests at the town of Mexico Beach yielded transmissivity values of 3700 and 10,200 ft^2/day, but continuing eastward, low transmissivity values dominate in Port St. Joe and Cape San Blas and average 500 ft^2/day or less. Transmissivities increase rapidly from Apalachicola eastward through Wakulla County, with tests on even relatively shallow wells yielding transmissivities of 2000 ft^2/day or greater in the karst limestone regions of the coastline.

Over the study area as a whole, not enough information is available to define zonations of transmissivity with depth. In Santa Rosa County, enough data was available to show a difference in transmissivity between wells completed in the upper part of the Upper Limestone of the Floridan Aquifer and wells that case off this zone and are completed at a lower depth (Figure 4). Data in the Panama City Beach area also suggests an increase in transmissivity with depth (Figure 5). Lithologic data suggests that this zonation may be District-wide. Throughout the District, the Suwannee and Ocala Limestones exhibit the greatest degree of secondary porosity development. In the coastal areas of the District, the Suwannee and Ocala limestones are overlain by the less permeable Tampa Stage formations--the Bruce Creek, the St. Marks and undifferentiated Tampa Stage Limestones. Shallower wells completed in the less permeable Tampa Stage Formations would show a lower transmissivity than deeper wells completed in the more permeable Suwannee and Ocala limestones.



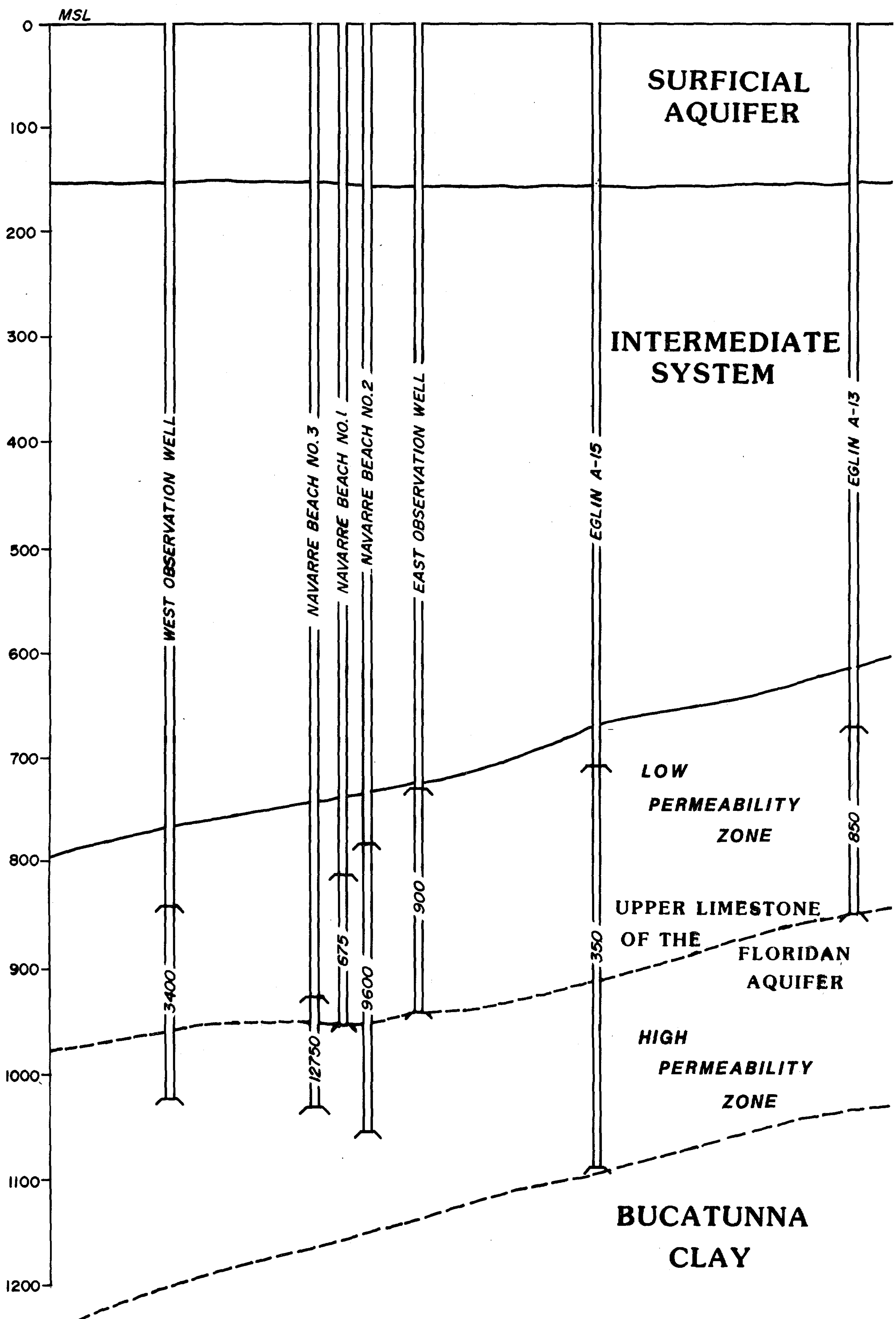
VALUES IN FT²/DAY

VERTICAL SCALE = 1 INCH TO 100 FT

HORIZONTAL SCALE = 1 INCH TO 8333 FT

– OPEN HOLE INTERVAL OF WELL

FIGURE 4 - VERTICAL ZONATION OF TRANSMISSIVITIES IN THE VICINITY OF PANAMA CITY BEACH, BAY COUNTY



VALUES IN FT²/DAY
VERTICAL SCALE = 1 INCH TO 100 FT.
HORIZONTAL SCALE = 1 INCH TO 8333 FT

– OPEN HOLE INTERVAL OF WELL

FIGURE 5 - VERTICAL ZONATION OF TRANSMISSIVITIES IN THE VICINITY OF NAVARRE BEACH, SANTA ROSA COUNTY

Table 3.--Representative Estimated Transmissivities for the Coastal Areas of Northwest Florida.

Well No.	Well Name	Total Depth (Feet)	Casing Depth (Feet)	Specific Capacity (Gal/Min/Ft)	Transmissivity (Ft^2/day)
1	West Observation Well	1020	840	11.46	3400
2	Navarre Beach #1	950	810	2.2	675
3	Navarre Beach #2	1051	782	34.0	9600
4	Navarre Beach #3	1030	925	46.7	12750
5	East Observation Well	940	730	1.4	900
7	Eglin A-13	835	654	3.0	450
9	Eglin A-10	822	580	3.8	1050
10	Eglin A-7	738	538	1.7	500
12	Okaloosa Island Auth #4	736	545	2.7	750
14	Okaloosa Island Auth #2	845	455	1.3	350
13	Okaloosa Island Auth #3	867	528	1.2	300
16	Eglin A-3	735	505	1.7	450
20	Destin #3	731	450	37.6	11650
23	NWFWMD Crystal Beach	710	380	28.0	9000
24	South Walton #3	554	410	181.8	11000
26	South Walton #2	595	395	22.2	6150
27	South Walton #4	554	410	181.8	11000
31	Dune 1 Floridan	443	321	1.6	500
43	Inlet Beach #1	427	94	4.4	625
44	Inlet Beach #2	578	231	1.1	280
46	Panama City Beach #1	733	313	27.8	8500
51	Panama City Beach #7	426	284	2.4	600
52	Panama City Beach #8	439	275	1.8	450
55	US Navy Mine Defense Lab #3	473	250	3.9	1000
56	Point Royale Development	525	284	2.1	575
64	Tyndall AFB #4	411	332	11.6	3165
66	Mexico Beach #1	485	412	13.8	3700
67	Mexico Beach #2	590	190	22.9	10200
69	Port St. Joe #3	656	420	1.6	450
71	Lighthouse #2	623	422	1.2	500
80	Apalachicola #4	465	330	22.0	5850
81	Bobby Kirvin	376	285	16.1	5000
85	Leisure Properties #1	263	170	8.6	2300
86	Allan C. Hubanks	96	90	7.6	2250
90	Emily Kemp	109	96	9.3	2800

Table 3.--Representative Estimated Transmissivities for the Coastal Areas of Northwest Florida. - (continued)

Well No.	Well Name	Total Depth (Feet)	Casing Depth (Feet)	Specific Capacity (Gal/Min/Ft)	Transmissivity (Ft^2/day)
93	Town of Panacea	57	40	2.5	700
94	Panacea #2	79	42	13.2	3375
95	Panacea #4	113	78	16.7	4800
98	TEC Gulf Coast #2	189	62	52.9	17500
99	TEC Shell Point #1	178	31	1.0	275

WATER QUALITY

In examining the existing water quality of the coastal area of northwest Florida, chloride concentration was used to indicate the possible extent of saltwater influence on the quality of water in the Floridan Aquifer. Chloride concentration was used because it is a good indicator of saltwater movement and because chloride was the only water quality parameter measured in most wells. In some areas information on other water quality parameters is available and is summarized in this report. An effort was made to use the most recent data available; however, in some areas, especially in Bay County, the only available water quality information dates from the late 1950's and early 1960's.

Water quality in the Floridan Aquifer varies widely due to both natural and man-made factors. As a trend, the Floridan becomes increasingly saline towards the west, as the limestone formations which comprise the Floridan dip more deeply below the land surface. Localized areas of poor quality water are found in the Choctawhatchee Bay area, in the Apalachicola River area in Gulf and Franklin counties, in Bay and Gulf counties, where highly mineralized water is known to exist at relatively shallow depths within the Floridan Aquifer and in the Spring Creek area, where the saltwater/freshwater interface may be located inland from the coast. Other areas, such as the Fort Walton Beach area, appear to show a low level increase in chloride concentrations attributable to large Floridan Aquifer withdrawals.

In order to examine the relationships of geology and water quality, a series of cross sections was constructed. Tops and bases of aquifers and confining units, as identified by Wagner and others (1985) were plotted for selected wells along the coast. Chloride concentrations and depth were then plotted for all Floridan depth wells with available data. The resulting cross sections were contoured to show the approximate positions of the 50 mg/L, the 100 mg/L and the 250 mg/L isochlors. The result is an approximate picture of how chloride concentrations vary with depth along the coast.

Because the chloride concentrations are plotted as occurring at the bottom of the well, the picture shown is somewhat optimistic. Most of the wells used as data points have large lengths of open hole. When the well is pumped, water can enter the borehole along the entire length of the open hole, although most of the water is produced from the more permeable intervals within the aquifer that the well penetrated. Therefore, the collected sample is a composite of water from the different zones that the well penetrates. Since more saline water generally occurs with depth, using this composite chloride concentration results in a cross section which shows better water quality than is probably actually present at the bottom of the well. The cross sections are still the best method of utilizing the available information because they show trends in chloride concentration in the aquifer, even if the numbers may be somewhat low, and because they show the chloride concentrations as pumped from the wells that the monitoring system is designed to protect.

Enough data is available from Santa Rosa County to the Gulf County/Franklin County line to indicate patterns of chloride distributions (See Figures 6 through 8.) Eastward from Gulf County, however, data was extremely limited. Lithology data shows both the Surficial Aquifer and the confining unit of the Intermediate System thinning, until finally, the Floridan Aquifer is at or very near the surface in coastal Jefferson and Wakulla counties. Chloride data is only available for scattered locations along the coast in this area and no clear trends were evident. The data available for this area is shown on Figure 9.

Santa Rosa County Through Walton County

Because the coasts of Santa Rosa, Okaloosa and Walton counties have undergone more development than other areas of the District, a good coverage of data is available for this area (Figure 6). This area of the coastline shows the most variation in lithology. At the westernmost part of the cross section, the Surficial (Sand-and-Gravel) Aquifer is approximately 150 feet thick and the Intermediate System is represented by a 600+foot thickness of confining sediments. The top of the Upper Limestone of the Floridan Aquifer is at about 740 feet below mean sea level and the Bucatunna Clay is present at approximately 1150 feet below mean sea level in this area.

At the eastern end of the figure, at the Walton County/Bay County line, the Surficial Aquifer has thinned to about 50 feet and the Intermediate System is only about 200 feet thick. The top of the Floridan is at approximately 250 feet below mean sea level. The Bucatunna Clay is no longer present and the Floridan Aquifer is undifferentiated.

The area of coast covered by this cross section also shows a large amount of variability in water quality. The five wells associated with Navarre Beach, with chloride concentrations ranging from 100 to 150 mg/L, mark the westernmost limit of use of the Floridan Aquifer for water supply in the coastal area. Chloride concentrations appear to decrease rapidly away from the coast. Northwest of Navarre Beach, on Fair Point Peninsula, water in the Floridan Aquifer is considerably fresher, with chloride concentrations between

20 mg/L and 70 mg/L measured in the Floridan depth wells of the Midway and Holley Navarre Water Systems.

Water quality gradually improves toward the east. An apparent slight upconing of poorer quality water is seen under the Okaloosa County Island and Destin service areas, with chloride values ranging between 60 and 75 mg/L. An estimate of water quality as interpreted from geophysical logs is available for the NWFWMD Crystal Beach well at the Okaloosa/Walton County line. Chloride concentrations of 100 mg/L were estimated for the interval from 422 to 622 feet, with a rapid increase in concentration to 1,500 mg/L measured at the total depth of 708 feet below mean sea level. A sample collected from the well showed a chloride concentration of 35 mg/L, indicating that most of the water is produced from shallower, fresher zones within the aquifer.

At approximately the Walton County/Okaloosa County line, the Bucatunna Clay is absent or thins to the point where it no longer effectively separates the Upper and Lower limestones of the Floridan Aquifer. Water in the Lower Limestone is more saline and under a higher head than water in the Upper Limestone. Where the Bucatunna Clay is absent, poorer quality water from the Lower Floridan can move upwards, causing degradation of the water in the upper part of the aquifer. High concentrations of chlorides are measured in wells penetrating the Floridan Aquifer in this vicinity. Many of the chloride concentrations exceed the Florida Maximum Contaminant Level for drinking water of 250 mg/L. Chloride concentrations as high as 1045 mg/L have been measured in domestic wells on the southern shore of Choctawhatchee Bay. A previous investigation by Barr and others (1981) found that elevated chloride concentrations were also present on the north side of Choctawhatchee Bay. Chloride concentrations are generally low to very low to the east and the west of this area; concentrations in the South Walton Utilities wells immediately

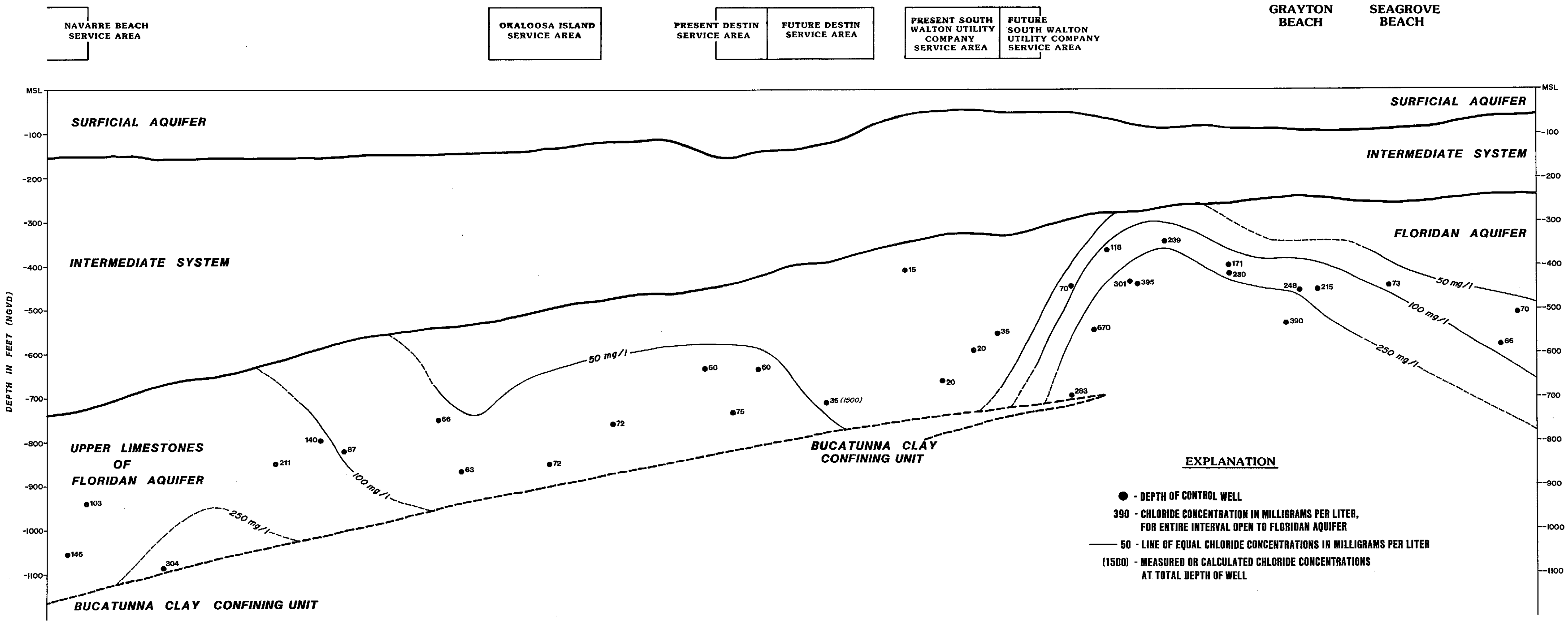


FIGURE 6 - CHLORIDE CROSS-SECTION , NAVARRE BEACH, SANTA ROSA COUNTY TO INLET BEACH, WALTON COUNTY

west of the Okaloosa/Walton County line range from 15 to 35 mg/L. The potential for movement of this poorer quality water toward South Walton Utilities wells exists and should be carefully monitored.

Not enough information was available to construct water quality cross sections for other ion concentrations besides chloride. However, water quality in this area has been examined in several recent reports (Barr and others, 1985; Barr and others, 1981, Trapp and others, 1977 and Pascale, 1974) and some information on sodium and fluoride concentrations is available. According to Barr and others (1981), high sodium concentrations are found in the Floridan Aquifer in southeastern Walton County, southeastern Okaloosa County and southern Santa Rosa County. In coastal and western Okaloosa counties, sodium concentrations range from about 100 mg/L to more than 160 mg/L, with wells in the eastern Choctawhatchee Bay area showing sodium concentrations exceeding 300 mg/L (Barr and others, 1985). High sodium concentrations are generally found in wells with high chloride concentrations, indicating some degree of mixing with saline water from deeper zones or with sea water. Trapp and others (1977) report elevated fluoride concentrations (values greater than 1.0 mg/L) in the southwestern part of Okaloosa County and in a strip along the coast extending to Destin.

Bay County

From west to east across coastal Bay County, lithology remains fairly constant (Figure 7). The thickness of the Surficial Aquifer varies between about 50 feet and 100 feet. At the western edge of the cross section, the Intermediate System is approximately 200 feet thick. The Intermediate thickens gradually to the east towards the axis of the Apalachicola Embayment structural depression, reaching a thickness of about 400 feet at the Bay County/Gulf County border. The top of the Floridan Aquifer is at approximately 250 feet below mean sea level in the west, dipping to 450 feet below mean sea level in the east.

Chloride concentrations vary from west to east along the Bay County coast. The upper 100 to 200 feet of the Floridan Aquifer has water with less than 50 mg/L of chlorides from Tyndall Air Force Base westward. Chloride concentrations increase with depth, with higher concentrations found under Panama City Beach and Tyndall Air Force Base. Because the available data ranged in age from the early 1960's through the 1980's and is very scattered, this trend cannot be defined with any accuracy. However, it appears that high chloride concentrations (250 mg/L or greater) can be found in the Panama City Beach area at depths as shallow as 600 feet below mean sea level. At Tyndall Air Force Base, one 600-foot deep well showed a chloride concentration of 330 mg/L.

According to Barr and Wagner (1981), chloride concentrations in the Panama City Beach public supply wells indicate a clear distribution of chlorides with depth. Wells #7 and #8, which are less than 500 feet in depth, show chloride concentrations of 9 and 16 mg/L, respectively. The other ten wells, which range in depth from 708 to 874 feet, show chloride concentrations of 102 mg/L to 244 mg/L. One well, Well #6 has been abandoned because of high chloride concentrations. Barr and Wagner (1981) attribute high chloride concentrations in these wells and in the Tyndall Air Force Base wells to a decline in the potentiometric surface of the Floridan Aquifer caused by heavy pumping and insufficient spacing between wells. This decline in the potentiometric surface allows more saline water under higher pressure deeper in the aquifer to move upwards into the fresher zones tapped by the wells.

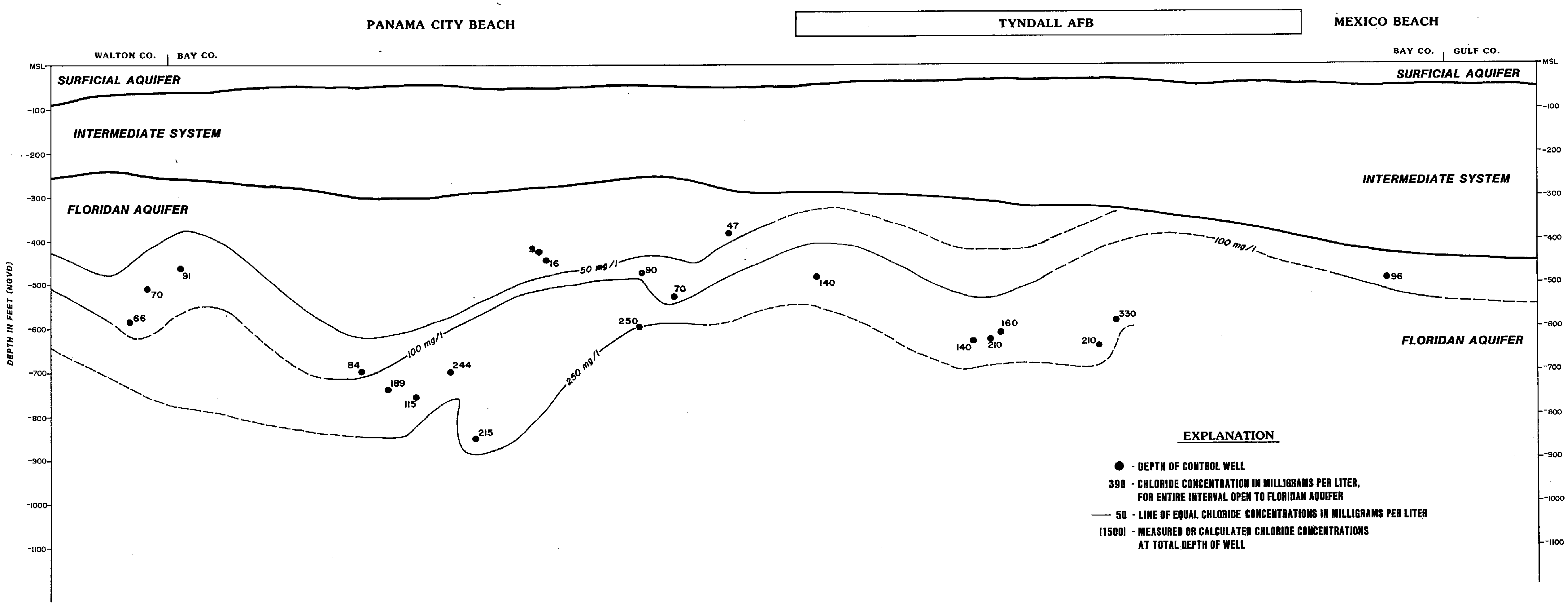


FIGURE 7 - CHLORIDES CROSS-SECTION, BAY COUNTY

Increases in chloride concentrations with depth can also be seen in the Panama City Beach area at the U. S. Navy Mine Defense Laboratory. In wells #1 and #2, with total depths of approximately 600 feet below mean sea level, measured chloride concentrations have ranged between 220 mg/L and 320 mg/L. A shallower well, Well #3, later constructed in the same location to a total depth of 473 feet below mean sea level, has chloride concentrations of 90 mg/L.

Water quality problems are evident in two other areas in coastal Bay County. One is the Mexico Beach area, discussed in the next section, where elevated fluoride concentrations have caused the removal of a public water supply well from service. Foster (1972) described a tongue of Floridan Aquifer water with high fluoride concentrations extending up the coast of southern Bay County from the Bay County/Gulf County line to approximately St. Andrews Bay. The other area is at the Bay County/Walton County line. Chloride concentrations of 91 mg/L have been measured at the Camp Helen well in Bay County while the Inlet Beach wells, about two miles away in Walton County, showed chloride concentrations of 22 mg/L and 53 mg/L at similar depths.

Gulf County to Jefferson County

Chloride concentration data becomes increasingly sparse from Bay County eastward (Figures 8 and 9). The Surficial Aquifer remains about 50 feet thick through Gulf County but thins gradually through Franklin and Wakulla counties until it is represented by less then five feet of surficial sands. The Intermediate System maintains a thickness of between 400 and 500 feet through Gulf County, then thins on the eastern flank of the Apalachicola Embayment structural depression in Wakulla County until it disappears entirely in coastal Jefferson County. The top of the Floridan Aquifer, which is at approximately 400 to 500 feet below land surface in Gulf County, rises to the land surface at the vicinity of Cobbs Rocks in coastal Jefferson County.

Elevated fluoride levels have been reported from wells along the coast from the vicinity of Mexico Beach, near the Bay County/Gulf County line, to Cape San Blas in Gulf County (Figure 8). In these wells, high fluoride and sodium levels are associated with relatively low chloride concentrations (See Table 4). At the Mexico Beach Well #1, fluoride concentrations were 3.1 mg/L, with sodium concentrations of 140 mg/L and chloride concentrations of 96 mg/L. In the Port St. Joe municipal Well #1, fluoride concentrations were 2.5 mg/L, with sodium concentrations of 22 mg/L and chloride concentrations of 12 mg/L. At Cape San Blas, fluoride concentrations ranged between a high of 13 mg/L on the Cape to 0.72 mg/L on the mainland. Insufficient data is available to further define the extent of the high fluoride area or to indicate whether it is caused by upconing of saline water or is naturally present in the Floridan. Since the Florida Maximum Contaminant Level for fluoride in drinking water is 1.4 mg/L, these elevated concentrations are of concern because the water

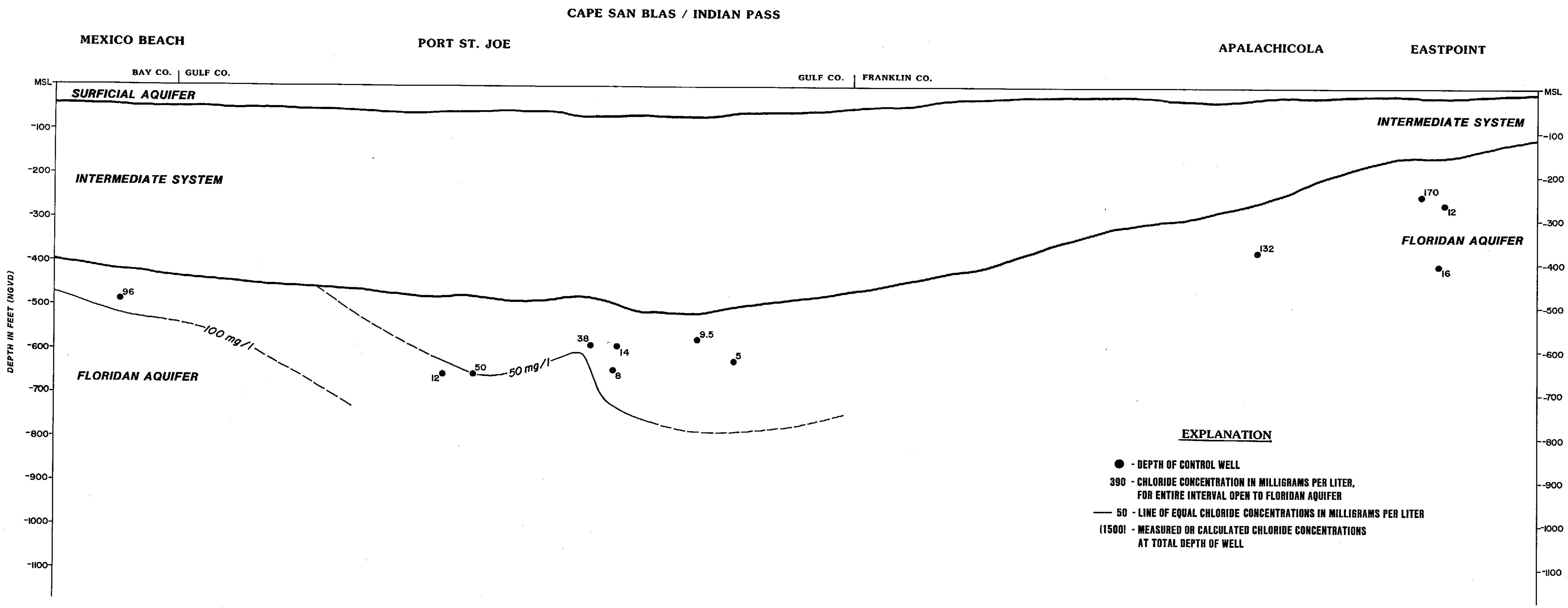
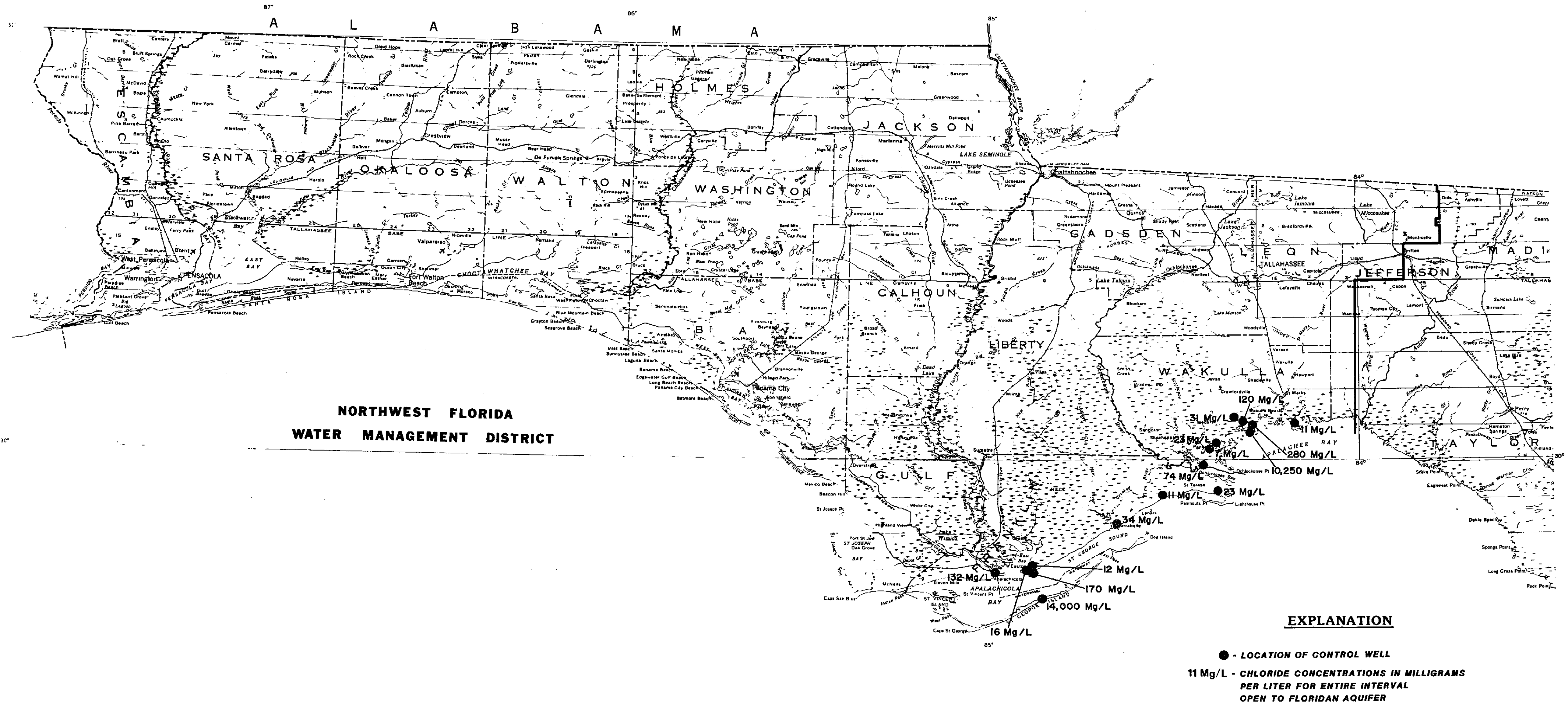


FIGURE 8 - CHLORIDES CROSS-SECTION , GULF AND FRANKLIN COUNTIES.



Florida Statute Chapter 373
Water Management District Boundaries
July 1, 1975

Base map prepared by
U.S. GEOLOGICAL SURVEY
Tallahassee, Florida
August 1974
from State of Florida Map
1:500,000 Edition of 1967

0 10 20 MILES

FIGURE 9 - CHLORIDE CONCENTRATIONS IN FRANKLIN AND WAKULLA COUNTIES

cannot be used for public water supply. The city of Mexico Beach was recently directed to remove a well from service because of high fluoride concentrations. A new well constructed to a greater depth showed initial low levels of fluoride.

Table 4.--Water Quality in Coastal Areas of Gulf and Southern Bay Counties.

Well No.	Well Name	Chloride mg/L	Sodium mg/L	Fluoride mg/L	Date Sampled
66	City of Mexico Beach #1	96.0	140.0	3.1	05/62
67	City of Mexico Beach #2	14.5		0.1	09/82
68	Port St. Joe #1	12.0	22.0	2.5	03/74
70	Lighthouse Utilities #1	4.5	40.0	1.1	01/83
71	Lighthouse Utilities #2	4.9	9.5	0.7	06/85
74	Eglin Site D-3, Well #1	8.0	160.0	13.0	09/62
75	Eglin Site D-3, Well #2	8.0	160.0	9.0	03/69

Chloride concentration data is very incomplete east of this area and consists mainly of information at towns along the coast. For this reason, data from wells east of Apalachicola are shown on a map (Figure 9) instead of on a cross section. Water quality in the Apalachicola area is apparently poor. One domestic well showed chloride concentrations of 132 mg/L, while a flowing well of unknown depth at Apalachicola has consistently showed chloride concentrations of between 620 and 820 mg/L. Limited data suggests that chloride concentrations may be high inland along reaches of the Apalachicola River basin. Chloride concentrations of 206 and 231 mg/L were measured in two Floridan depth wells at the MK Ranch, located about 15 miles from the coast and within five miles of the Apalachicola River in Gulf County.

In 1971, a 1,026-foot deep well was drilled on St. George Island in search of a source of water supply. Trapp (1977) reports that the water from the well was too saline to be usable. Samples were taken at four depths and analyzed for a variety of parameters. Table 5 shows concentrations of chloride, sodium fluoride and total dissolved solids at the sampled depths. This data suggests that the saltwater/freshwater interface is located between St. George Island and the mainland of Franklin County.

Table 5.--Chemical Analyses of Water Samples from St. George Island Test Well.

Depth (Feet)	Date	Chloride (mg/L)	Fluoride (mg/L)	Sodium (mg/L)	Total Dissolved Solids (mg/L)
217	08/23/71	800	0.1	295	1640
470	08/25/71	14400	0.6	7840	27100
602	09/03/71	12800	1.6	6910	24000
1026*	08/25/72	2100	0.1	950	------

* Casing had been pulled and lower part of well may have caved.
Source: Trapp, 1977.

Information at Eastpoint, in Franklin County shows relatively low chloride concentrations, as does available data for Carrabelle and the Alligator Point vicinity. Chloride concentrations in the vicinity of Panacea are fairly low, generally less than 50 mg/L. However, Pascale and Wagner (1982) document a case of saltwater intrusion near Ochlockonee Bay south of the town of Panacea. Two water supply wells were constructed in 1965 and used until 1970, when chloride levels increased sharply. One of the wells was abandoned and the other is presently only used for emergencies. In 1968, the Bureau of Geology drilled and sampled a series of test wells in the area and found that the aquifer naturally contained salt water below 160 feet below mean sea level. The presence of the salt water in the Panacea wells was attributed to upconing caused by withdrawals.

Eastward of Panacea, the next available data is for the Spring Creek/ Shell Point area in Wakulla County. Floridan depth wells sampled in this area showed a large amount of variability in chloride concentration. A chloride concentration of 10250 mg/L was measured in a shallow Floridan well at the coast. At about 2.5 miles inland, the Talquin Electric Cooperative's (TEC) Shell Point wells show chlorides of 120 mg/L and 112 mg/L. At two other TEC wells approximately one mile further inland, chloride values have dropped to 23 mg/L and 31 mg/L. This data may indicate a steep sharp saltwater/ freshwater interface inland of the coast.

The easternmost available data point is at the St. Marks Wildlife Refuge and shows 11 mg/L of chloride at a depth of 60 feet below mean sea level. No information is available for coastal Jefferson County.

COMPREHENSIVE MONITORING PLAN

In designing a ground-water monitoring network for the coastal regions of the northwest District, several factors must be considered. First, the network should be designed as a long-term network. Well sites must be undisturbed and accessible over a long period of time and the well construction should be such that the wells will function for at least 20 years. Second, because of the lack of data in some parts of the study area, the network must be designed to collect basic data in some areas while also serving as a monitoring system overall. In some locations, it may be necessary to monitor more than one zone or to space monitor wells more closely together. Third, the network should be designed to monitor saltwater movement as efficiently as possible. In any long-term ground-water monitoring system, the major expense is not the construction of the wells but rather the expense of sample collection and analysis that continue over the years. Therefore, the well location, the well construction and the parameters for which the well is tested must all be carefully considered. Fourth, the network should include the use of existing monitoring wells along the coast, where they meet the requirements of this program. In many cases, wells were constructed specifically for monitoring and are designed to monitor the same zones indicated by this study as zones of interest. These wells have the advantage of already having existing water quality data that can be used to supplement future data collected by the network.

There are four types of areas along the northwest District coast where additional ground-water monitoring is needed. These areas include: 1) areas of little or no data; 2) areas which show current saltwater movement or have experienced saltwater intrusion in the past; 3) areas of large ground-water withdrawals and associated drawdowns; and 4) areas where rapid development is occurring, with an associated greater demand on the ground-water resources. At some locations, construction of more than one monitor well is proposed to monitor zones of variable water quality. Some inland locations are proposed to monitor effects of cones of depression or to delineate areas of suspected saltwater contamination.

The following sections detail the recommended monitor well locations by county. General areas are specified rather than exact sites. It has been the experience of the NWFWMD in the construction of another long-term ground-water monitoring network that the exact site of a well is determined by such factors as ownership of the land, length of time over which access to the well will be possible and ease of access. Actual siting of each well must be done on an individual basis. Table 6 summarizes recommended monitor well locations and rationales for their selection. Figure 10 shows proposed monitor well locations.

Monitor Well Locations

Jefferson County

The construction of one well is proposed for coastal Jefferson County. This area is largely unpopulated and is unlikely to face a large increase in water use. One well should be adequate to characterize the water quality and

Table 6.--Proposed Monitor Well Locations and Rationales for Selection.

Well No.	Monitor Well Location	Location Rationale
Jefferson County		
1	Coastal Jefferson County	No Data
Wakulla County		
2	St. Marks Wildlife Refuge	No Data
3	Wakulla Beach-Shallow	No Data
4	Wakulla Beach-Deep	No Data
5	Shell Point Area-Onshore	No Data/Saltwater Interface Onshore
6	Shell Point Area-Inland	No Data/Find Saltwater Interface
7	Panacea-Shallow	Saltwater Contamination
8	Panacea-Deep	Saltwater Contamination
9	Ochlockonee Point	No Data
Franklin County		
10	Lighthouse Point	No Data
11	St. Teresa	No Data
12	Lanark Village	No Data
13	Carrabelle-Shallow	No Data
14	Carrabelle-Deep	No Data
15	Royal Bluff	No Data
16*	Eastpoint Ambient Well	Recently Drilled Well of Known Construction
17	St. George Island	No Data
18	Apalachicola-Shallow	No Data/Possible Saltwater Contamination
19	Apalachicola-Deep	No Data/Possible Saltwater Contamination
Gulf County		
20	Apalachicola Embayment	No Data/Possible Saltwater Contamination
21	Apalachicola Embayment	No Data/Possible Saltwater Contamination
22	Apalachicola Embayment	No Data/Possible Saltwater Contamination
23	Eleven Mile	No Data
24	St. Joe's Spit	Elevated Fluorides
25	Cape San Blas	Elevated Fluorides
26	Between McNeil's and Port St. Joe	Elevated Fluorides

Table 6.--Proposed Monitor Well Locations and Rationales for Selection. - (continued)

Well No.	Monitor Well Location	Location Rationale
27*	Port St. Joe Ambient Well	Recently Drilled Well of Known Construction, High Fluorides
28	Between Mexico Beach and Port St. Joe	No Data, High Fluorides
Bay County		
29	Mexico Beach-Shallow	High Fluorides, Total Dissolved Solids
30	Mexico Beach-Deep	High Fluorides, Total Dissolved Solids
31	Tyndall AFB	No Recent Data, Indications of Possible Saltwater Contamination in Past
32	Tyndall AFB	
33	Tyndall AFB	
34*	Panama City Ambient Well	Recently Drilled Well of Known Construction
35	Southport	Large Withdrawals, No Data
36	St. Andrews State Park	Saltwater Interface at 600 Ft. Below MSL
37	Point Royale	Saltwater Interface at 600 Ft. Below MSL
38	Panama City Bch-Shallow	No data, Permeability Zonation
39	Panama City Bch-Deep	No data, Permeability Zonation
40	West Panama City Beach	Saltwater Interface at 600 Ft. Below MSL
41	Camp Helen	High Chlorides
Walton County		
42	Camp Creek/Eastern Lake	Monitor High Chloride Concentrations
43	Seagrove Beach	Need Data at Depth to Define Interface
44*	Point Washington	Area of High Chloride Concentrations
45	North of Choctawhatchee Bay	See Above
46	Blue Mountain Beach Area	See Above
47*	W. A. Holley	See Above, Long-Term Data Available
48*	West Hewett	Monitor Well of Known Construction
49	Between S. Walton Utilities and Salt Water	Monitor Movement of Salt Water in Response to Pumping
50	S. Walton Utilities #5	See Above
Okaloosa County		
51	NWFWMD Crystal Beach	Monitor Well of Known Construction
52	Destin	Monitor Effect of Destin Pumping, Fort Walton Beach Cone of Depression
53	Okaloosa Island--Deep	Need Data at Depth to Define Interface
54	Okaloosa Island--Shallow	Investigate Permeability Zonation, Effects of Large Withdrawals and Cone of Depression

Table 6.--Proposed Monitor Well Locations and Rationales for Selection. - (continued)

Well No.	Monitor Well Location	Location Rationale
55	Well in Vicinity of Okaloosa County ISL-6	Area of Large Drawdown, Possible Saltwater Intrusion
56	Near Seashore Village #1	Monitor Effects of Fort Walton Beach Cone of Depression
57	Mary Esther Area	As Above
58	Shalimar Area	As Above
Santa Rosa County		
59	Eglin AFB on Santa Rosa Island, Santa Rosa County	Need Data, Monitor Effect of Fort Walton Beach Area Drawdowns
60*	Navarre Beach, East Well	Existing Monitor Well in Area of Interest
61*	Navarre Beach, West Well	Existing Monitor Well in Area of Interest
62	Midway Area	Area of Increasing Development
63	West of Navarre Beach	No Data, Locate Interface
64	West of Midway	As Above
65	Between Holley and the Yellow River	As Above

* Existing well proposed for inclusion in monitoring network.

Wakulla County

The construction of eight wells is proposed for coastal Wakulla County. The wells in the Panacea and Shell Point areas are designed to investigate possible saltwater movement that was indicated by existing data. In the Shell Point area, a shallow well is proposed close to the shore, with a deeper well one to two miles inland, both placed between the Talquin Electric Cooperative public supply wells and the coast. Both a shallow and a deep well are proposed for the Wakulla Beach area and for the Panacea area to provide information on transmissivity zonation within the Floridan and to provide better information on the depth of the saltwater/freshwater interface. Other wells are proposed for St. Marks Wildlife Refuge and Ochlockonee Point.

Franklin County

Ten wells are proposed for Franklin County, including one existing Floridan depth well recently constructed at Eastpoint for the Ambient Ground-Water Monitoring Program. Wells are proposed at Lighthouse Point, St. Teresa, Lanark Village, Carrabelle and Royal Bluff to provide data where none currently exists. Both a shallow and a deep well are proposed for Carrabelle, to investigate transmissivity zonations and the depth of the saltwater/freshwater interface. Two wells are proposed for the Apalachicola area, one shallow and one deep, to investigate the potential source of the high chloride water in the Floridan Aquifer in that area. One well is proposed for St. George Island to better define the location of the saltwater/freshwater interface.

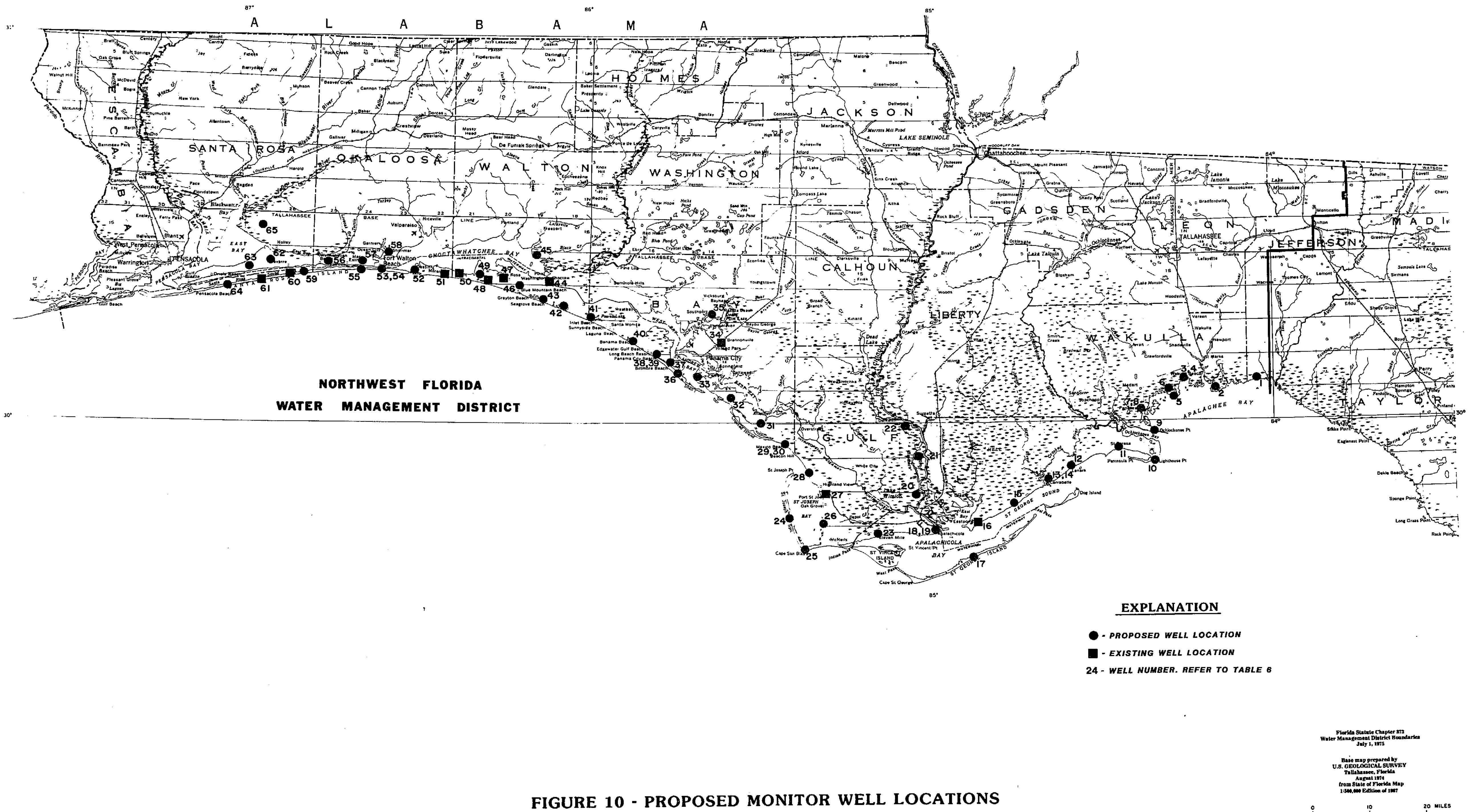


FIGURE 10 - PROPOSED MONITOR WELL LOCATIONS

Gulf County

The construction of eight new wells is proposed for coastal Gulf County, along with the use of an existing Ambient Ground-Water Monitoring Program well at Port St. Joe. The eight wells are proposed to provide basic hydrogeologic data and to investigate the high fluoride and sodium concentrations found along the coast and the high chloride concentrations found inland along the Apalachicola River. The Cape San Blas area, with three proposed monitor wells, is of especial interest because of a recent increase in the amount of pumpage from the Floridan Aquifer.

Bay County

A total of 13 wells is proposed to investigate and monitor saltwater movement in coastal Bay County. Two wells, a shallow well and a deep well, are proposed for the Mexico Beach area to investigate whether elevated fluoride concentrations vary with depth. Three wells are proposed for Tyndall Air Force Base to investigate elevated chloride levels associated with past large withdrawals and to examine the extent of the high fluoride concentrations in the Mexico Beach area. Additional wells are recommended for St. Andrews State Park, Point Royale, West Panama City Beach and Camp Helen. A pair of wells, one shallow and one deep, is recommended for the Panama City Beach area to investigate the apparent zonation of transmissivity and the increase in chloride concentrations with depth. Two wells are proposed inland from the gulf shore, to monitor potential saltwater movement in the deeply embayed Panama City area. The use of an existing well recently constructed in

Panama City for the Ambient Ground-Water Monitoring Network is recommended, as well as construction of a monitoring well in the Southport area, where large amounts of water are pumped from the Floridan Aquifer by a power-generating plant.

Walton County

Nine monitor wells are proposed for Walton County. Five of the wells, including four existing wells, are proposed to monitor the saline water in the Choctawhatchee Bay area, with one of the five wells located north of Choctawhatchee Bay to monitor the area of saltwater there. Placement of a monitor well is proposed for the area between the main body of the salt water and the South Walton Utility wells in order to monitor any movement of the salt water in response to the South Walton Utilities pumping. Use of South Walton Utility Well #5, proposed for construction in 1986, is also recommended for the same purpose. One well each is proposed for the Camp Creek/Eastern Lake area and Seagrove Beach.

Okaloosa County

Eight monitor wells are proposed for coastal Okaloosa County, including the use of the existing NWFWMD Crystal Beach monitoring well. One well is proposed for the Destin area, which is experiencing rapid growth and an increasing use of water from the Floridan Aquifer. Three wells are proposed for the Okaloosa Island area, including a pair of wells, one at approximately the total depth of the nearest supply wells and the other to the top of the Bucatunna Clay confining bed. Three wells are proposed on the mainland to monitor water quality associated with the major cone of depression in the Fort Walton Beach area: one at Shalimar, one in the Mary Esther area and one in the Seashore Village area.

Santa Rosa and Escambia Counties

Seven wells are proposed to monitor the coastal area of Santa Rosa County and to investigate the westward position of the saltwater/freshwater interface in the Upper Limestone of the Floridan Aquifer. The use of two existing monitor wells, the City of Navarre Beach's East and West monitor wells, is proposed. Construction of a third monitor well is proposed for the Midway area, to monitor potential changes in water quality caused by a projected large increase in the amount of pumpage from the Floridan Aquifer. A fourth well is proposed for the Eglin Air Force Base property near the Santa Rosa/Okaloosa County line, where data is lacking or contradictory. Three other wells are proposed to explore the western and northern positions of the saltwater interface: one well on Santa Rosa Island in Escambia County, west of Navarre Beach; one well on the mainland, west of Midway; and one well north of Holley, south of the Yellow River.

Monitor Well Construction Details

Two considerations must be made when designing the construction of a well to be used for monitoring. First, the well must be adequately designed to sample the portion of the aquifer desired while excluding water from other sources. Wells should be cased to the required depth and the annulus between the casing and the well bore filled with grout to exclude water which may otherwise move downward along the casing. The second consideration is ease of sample collection. In order to obtain a representative sample of aquifer water, the well must first be purged of the stagnant water in and around the well. Removal of approximately three well volumes of water to adequately flush the well is recommended before sampling takes place. In a large-diameter, deep well this may be a large amount of water, the removal of which may require the well to be pumped for several hours before the first sample can be taken. However, because of equipment-size constraints, the well casing diameter also cannot be too small, especially in productive areas where a four-inch diameter or larger pump may be necessary to move the volume of water needed to develop and flush the well.

A variety of types of monitoring well construction is necessary to adequately monitor the Floridan Aquifer along the length of the Northwest District coast. Proposed monitor well depths range between 100 and over 1000 feet. To facilitate sampling, well diameters of four inches for wells less than 500 feet deep, and well diameters of six inches for wells greater than 500 feet deep are recommended. Recommended casing materials are Schedule 40 or 80 PVC for wells less than 500 feet deep and steel casing for wells greater than 500 feet deep.

Table 7 contains recommended total depths, casing depths and diameters for each monitoring well proposed for construction. Given depths are approximations only, based on existing information for the top of the Floridan Aquifer and on depths and casing depths for surrounding wells. Casing depths are generally set so as to case off the Surficial Aquifer and Intermediate

System. Total depths are set either at or slightly below the zone from which public water supply wells in the vicinity of site withdraw their water, at the base of the Floridan Aquifer, or at depths which data indicate may show changes in water quality or transmissivity. All wells are designed to have open-hole completions.

Table 7.--Construction Specifications for Proposed Monitor Wells.

Map No.	Location	Total Depth (Feet)	Casing Depth (Feet)	Well Diameter (Inches)
Jefferson County				
1	Coastal Jefferson County	200	35	4.0
Wakulla County				
2	St Marks Wildlife Refuge	200	35	4.0
3	Wakulla Beach, Shallow	75	35	4.0
4	Wakulla Beach, Deep	500	50	6.0
5	Shell Point Area--Onshore	75	35	4.0
6	Shell Point Area--Inland	200	75	4.0
7	Panacea--Shallow	75	50	4.0
8	Panacea--Deep	200	50	4.0
9	Ochlockonee Point	200	50	4.0
Franklin County				
10	Lighthouse Point	200	50	4.0
11	St. Teresa	150	50	4.0
12	Lanark Village	200	50	4.0
13	Carrabelle--Shallow	200	100	4.0
14	Carrabelle--Deep	500+	100	6.0
15	Royal Bluff	200	150	4.0
16*	Eastpoint Ambient Well	192	142	4.0
17	St. George Island	500	100+	6.0
18	Apalachicola--Deep	600	250	6.0
19	Apalachicola--Shallow	400	250	4.0
Gulf County				
20	Apalachicola River Basin	500+	300	6.0
21	Apalachicola River Basin	500+	300	6.0
22	Apalachicola River Basin	600	250	6.0
23	Eleven Mile	600	350	6.0
24	St. Joe's Spit	700	500	6.0
25	Cape San Blas	700	500	6.0
26	Between McNeil's and Port St. Joe	700	400+	6.0
27*	Port St. Joe Ambient Well	410	360	4.0
28	Between Mexico Beach and Port St. Joe	500+	400	6.0

Table 7.--Construction Specifications for Proposed Monitor Wells. - (continued)

Map No.	Location	Total Depth (Feet)	Casing Depth (Feet)	Well Diameter (Inches)
Bay County				
29	Mexico Beach-Shallow	500	400	6.0
30	Mexico Beach--Deep	700	400	6.0
31	Tyndall AFB	700	350	6.0
32	Tyndall AFB	700	350	6.0
33	Tyndall AFB	500	300	6.0
34*	Panama City Ambient Well	210	160	4.0
35	Southport	400	100+	4.0
36	St. Andrews State Park	500	300	6.0
37	Point Royale	600	300	6.0
38	Panama City Beach--Shallow	450	300	4.0
39	Panama City Beach--Deep	600	300	6.0
40	West Panama City Beach	600	300	6.0
41	Camp Helen Area	600	250	6.0
Walton County				
42	Camp Creek/Eastern Lake Area	600	250	6.0
43	Seagrove Beach	600	250	6.0
44*	NWFWMD Pt. Washington	610	295	6.0
45	North of Choctawhatchee Bay	400	150	4.0
46	Blue Mountain Beach Area	500	300	6.0
47*	W. A. Holley	354	162	3.0
48*	West Hewett	707	277	4.0
49	Between S. Walton Utilities and Salt Water to East	550	350	6.0
50*	S. Walton Utilities #5	650	450	16.0
Okaloosa County				
51*	NWFWMD Crystal Beach	725	395	6.0
52	Destin Area	750	450	6.0
53	Okaloosa Island Area--Deep	850+	500	6.0
54	Okaloosa Island Area--Shallow	700	500	6.0
55	Well in Vicinity of Okaloosa County ISL-6	900	550	6.0
56	Near Seashore Village #1	900	550	6.0
57	Mary Esther	900	500	6.0
58	Shalimar	800	400	6.0

Table 7.--Construction Specifications for Proposed Monitor Wells. - (continued)

Map No.	Location	Total Depth (Feet)	Casing Depth (Feet)	Well Diameter (Inches)
Santa Rosa County				
59	Eglin AFB on Santa Rosa Island, Santa Rosa County	1100	700	6.0
60*	Navarre Beach, East Obs	940	730	6.0
61*	Navarre Beach, West Obs	1020	840	6.0
62	Midway Area	1200	750	6.0
63	West of Navarre Beach	1200	750	6.0
64	West of Midway	1200	850	6.0
65	Between Holley and the Yellow River	1200	700	6.0

* Existing well proposed for inclusion in monitoring network.

** Depths given are approximations only. Actual casing depth and total depth will be determined by the on-site geologist, based on such factors as lithology, water quality and water-bearing capacity.

Water Quality Parameters

This monitoring network is designed as a long-term network, to be sampled at set intervals over a number of years. In long-term networks, the major expense has been found to be the total cost of the sampling and analysis over a several-year period rather than the initial construction of the wells. The following recommendations are made to maximize the amount of data that can be collected from the proposed system in a cost efficient manner.

After the proposed wells are constructed, an initial sampling should be made of each of the network wells and of selected existing wells of known construction. Wells should be sampled by methods described in EPA SW-611 (U. S. Environmental Protection Agency, 1977) or an equivalent reference. In addition, water samples should be taken from selected depths in all wells in the network using a sampler designed to take ground-water samples at specified depths. It is recommended that these samples be analyzed for the parameters shown in Table 8. This full suite of parameters is recommended to provide current information on water quality along the coast and to allow identification of areas with saltwater intrusion or other water quality problems.

The information generated by the first sampling should then be analyzed and used to determine which monitor wells in which locations along the coast provide the most information. For instance, along coastal Wakulla, Jefferson and Franklin counties, a fairly high density of monitoring locations is proposed to provide data where none now exists. If, because of limited use of ground water and because of current good water quality, saltwater intrusion is shown to be unlikely, a lower density network of monitoring wells may actually be needed to monitor saltwater movement. If additional problems are identified, it may be necessary to construct additional monitor wells to better monitor problem locations.

Table 8.--Recommended Parameters for First Network Sampling.

Parameter	Units
Laboratory Parameters	
Dissolved Solids (Residue at 180° C)	Milligrams Per Liter
Dissolved Sulfate (SO_4)	Milligrams Per Liter
Dissolved Chloride (Cl)	Milligrams Per Liter
Dissolved Sodium (Na)	Milligrams Per Liter
Dissolved Fluoride (F)	Milligrams Per Liter
Hardness (Ca, Mg)	Milligrams Per Liter
Bicarbonate (HCO_3)	Milligrams Per Liter
Dissolved Calcium (Ca)	Milligrams Per Liter
Dissolved Magnesium (Mg)	Milligrams Per Liter
Dissolved Iron (Fe)	Milligrams Per Liter
Dissolved Potassium (K)	Milligrams Per Liter
Field Parameters	
Temperature (C°)	Degrees Centigrade
Specific Conductance	µmhos/cm at 25°C
pH	pH Units

Wells chosen for the final network should be monitored at least yearly for a suite of indicator parameters. These parameters will show general changes in water quality and provide information on saltwater movement.

Recommended parameters include chlorides, sodium and total dissolved solids, with field measurements of temperature, pH and conductivity (See Table 9).

Table 9.--Recommended Parameters for Long-Term Network Sampling.

Parameter	Units
Laboratory Parameters	
Dissolved Chloride (Cl)	Milligrams Per Liter
Dissolved Sodium (Na)	Milligrams Per Liter
Dissolved Fluoride (F)	Milligrams Per Liter
Total Dissolved Solids (TDS)	Milligrams Per Liter
Field Parameters	
Temperature (C°)	Degrees Centigrade
Specific Conductance	µmhos/cm at 25°C
pH	pH Units

SUMMARY AND CONCLUSIONS

Although up to four major water-bearing units may be present at any given location along the coast, this study concentrated on designing a monitoring system for the Floridan Aquifer. The Floridan Aquifer is the major source of ground-water supply in most of the coastal area. The only coastal county that was not represented in this study was Escambia County, where the shallower Sand-and-Gravel Aquifer is used as the primary source of water.

In general, ground-water pumpage in the Northwest District is concentrated in urban areas and along those portions of the coastline which have been extensively developed. Water-level declines have resulted from large ground-water withdrawals in the Fort Walton Beach area, where a regional cone of depression with maximum declines of greater than 240 feet has formed. Panama City and Port St. Joe are areas where cones of depression have developed in the recent past, but in both cases, conditions returned to normal after surface water sources were developed as an alternative water supply.

A large amount of chemical and hydrologic variability occurs in the Floridan Aquifer from east to west along the Northwest District's coast. The top of the Floridan Aquifer is at or near land surface in Jefferson and Wakulla counties and dips to 700 feet below mean sea level in Santa Rosa County. Transmissivities also varied widely along the coast, with higher transmissivities found in Wakulla and eastern Franklin counties, low transmissivities through the mid portion of the Apalachicola Embayment area, and higher transmissivities for the areas of Panama City Beach, the Destin area and Navarre Beach. Limited information indicates an increase in permeability with depth.

Water quality in the Floridan Aquifer varies widely due to both natural and man-made factors. In general, the water in the Floridan becomes increasingly saline toward the west, as the aquifer dips more deeply below the land surface. Localized areas of poorer quality water are found in the Choctawhatchee Bay area in southern Okaloosa and Walton counties, in the stretch of coast between Mexico Beach in Bay County and Cape San Blas in Gulf County, along the Apalachicola River in Franklin and Gulf counties and in the Spring Creek area of Wakulla County. Areas where saltwater contamination has occurred because of ground-water withdrawals include the Panacea area in Wakulla County, Panama City Beach and Tyndall Air Force Base in coastal Bay County and the Fort Walton Beach and Destin area in Okaloosa County, which appears to show a low-level increase in chloride concentration when compared to surrounding areas.

Analysis of data gathered during this study indicates that there is a need for a ground-water monitoring network in the coastal areas of the Northwest District. There are four types of areas along the Northwest District coast where monitoring is needed: 1) areas of little or no data; 2) areas where poor quality water is present in the Floridan Aquifer, either because of natural or man-induced factors; 3) areas showing large amounts of drawdown; and 4) areas where rapid development is occurring and placing an increased demand on water resources.

A total of 65 monitor wells is proposed for the coastal ground-water monitoring network: 56 wells to be constructed for this project and nine existing monitor wells that are ideally located and of known construction. Proposed monitor well depths range between 75 feet and 1200 feet and at least one monitor well is proposed for each coastal county. A two-step sampling program is proposed, with an initial comprehensive analysis of several water quality parameters, to be followed with a long-term sampling and analysis program utilizing a limited number of indicator parameters.

REFERENCES

Barr, Douglas E., Larry R. Hayes, and Thomas Kwader, 1985, Hydrology of the Southern Parts of Okaloosa and Walton Counties, with Special Emphasis on the Upper Limestone of the Floridan Aquifer, U. S. Geological Survey Water Resources Investigations Report 84-4305.

Barr, Douglas E. and Jeffry R. Wagner, 1981, Reconnaissance of the Ground Water Resources of Southwestern Bay County, Northwest Florida Water Management District Technical File Report 81-8.

Barr, Douglas E., Agustin Maristany and Thomas Kwader, 1981, Water Resources of Southern Okaloosa and Walton Counties, Northwest Florida, Northwest Florida Water Management District Water Resources Investigation 81-1.

Chen, Chih Shan, 1965, The Regional Lithostratigraphic Analysis of Paleocene and Eocene Rocks of Florida, Florida Bureau of Geology Bulletin No. 45, 105 p.

Clark, Murlene Wiggs and Walter Schmidt, 1982, Shallow Stratigraphy of Okaloosa County and Vicinity, Florida Bureau of Geology Report of Investigations No. 92.

Coffin, John E., 1982, Summary of Groundwater and Surface Water Data for City of Pensacola and Escambia County, Florida, U. S. Geological Survey Open File Report 82-361.

Cole, W. Storrs, 1945, Stratigraphic and Paleontologic Studies of Wells in Florida, Florida Bureau of Geology Bulletin No. 28, 160 p.

Foster, James B., 1972, Guide to Users of Groundwater in Bay County, Florida, Florida Bureau of Geology Map Series No. 46.

Hayes, Larry R. and Douglas E. Barr, 1983, Hydrology of the Sand-and-Gravel Aquifer, Southern Okaloosa and Walton Counties, U. S. Geological Survey, Water Resources Investigations Report 82-4110.

Kranzer, Bonnie S., 1983, Water Use in the Northwest Florida Water Management District, Northwest Florida Water Management District Special Report 83-8.

Kwader, Thomas and Walter Schmidt, 1978, Top of the Floridan Aquifer in Northwest Florida, Florida Bureau of Geology Map Series No. 86.

Marsh, Owen T., 1966, Geology of Escambia and Santa Rosa Counties, Western Florida Panhandle, Florida Bureau of Geology Bulletin No. 46, 140 p.

Musgrove, Rufus H., Jack T. Barraclough and Rodney G. Grantham, 1965a, Water Resources of Escambia and Santa Rosa Counties, Florida, Florida Bureau of Geology Report of Investigations No. 40.

Musgrove, Rufus H., J. B. Foster and L. G. Toler, 1965b, Water Resources of the Econfina Creek Basin Area in Northwestern Florida, Florida Bureau of Geology Report of Investigations No. 41.

Pascale, Charles A., 1974, Water Resources of Walton County, Florida, Florida Bureau of Geology Report of Investigations No. 76.

Pascale, Charles A. and Jeffry R. Wagner, 1982, Water Resources of the Ochlockonee River Area, Northwest Florida, U. S. Geological Survey Open File Report 81-1121.

Pratt, Thomas R. and Douglas E. Barr, 1982, Availability and Quality of Water from the Sand-and-Gravel Aquifer in Southern Santa Rosa County, Florida, Northwest Florida Water Management District Water Resources Special Report No. 82-1.

Puri, Harbans S., 1954, Contribution to the Study of the Miocene of the Florida Panhandle, Florida Bureau of Geology Bulletin No. 36, 345 p.

Schmidt, Walter, 1983, Neogene Stratigraphy and Geologic History Apalachicola Embayment, Florida, Unpublished Dissertation, Florida State University, Department of Geology.

Schmidt, Walter and Murlene Wiggs Clark, 1980, Geology of Bay County, Florida, Florida Bureau of Geology Bulletin No. 57, 96 p.

Trapp, Henry Jr., 1977, Exploratory Water Well, St. George Island, Florida, U. S. Geological Survey Open File Report 77-652.

Trapp, Henry Jr., 1975, Hydrology of the Sand-and-Gravel Aquifer in Central and Southern Escambia County, Florida, Preliminary Report--November, 1973. U. S. Geological Survey Open File Report FL-74027.

Trapp, Henry Jr., 1972, Availability of Ground Water for Public Supply in the Pensacola Area, Florida, U. S. Geological Survey Open File Report 72002.

Trapp, Henry Jr., C. A. Pascale and J. B. Foster, 1977, Water Resources of Okaloosa County and Adjacent Areas, Florida, U. S. Geological Survey Water Resources Investigations 77-9.

U. S. Environmental Protection Agency, 1977, Procedures Manual of Ground Water Monitoring at Solid Waste Disposal Facilities, EPA/530/SW-611.

REFERENCES - (continued)

Wagner, Jeffry R., 1986, December 15, 1985, Written Communication, Northwest Florida Water Management District.

Wagner, Jeffry R., Thomas W. Allen, Linda Ann Clemens and James B. Dalton, 1985, Ambient Groundwater Monitoring Program--Phase 1: Northwest Florida Water Management District, DER Contract No. WM65.

Wagner, Jeffry R., Elizabeth A. Hodecker and Robert Murphy, 1980a, Evaluation of Industrial Water Availability for Selected Areas of the Northwest Florida Water Management District, Northwest Florida Water Management District Water Resources Assessment No. 80-1.

Wagner, Jeffry R., Charles Lewis, Larry R. Hayes and Douglas E. Barr, 1980b, Hydrologic Data for Okaloosa, Walton and Southeastern Santa Rosa Counties, Florida, U. S. Geological Survey Open File Report 80-741.

Walton, William C., 1970, Ground Water Resource Evaluation, McGraw-Hill Book Company, U. S. A.

Yon, J. William, 1966, Geology of Jefferson County, Florida, Florida Bureau of Geology Bulletin No. 48, 115 p.

APPENDICES

Appendix A: Selected Wells in the Coastal Areas of the Northwest District.

Appendix B: Major Water Users in Coastal Areas of the Northwest District.

APPENDIX A: Selected Wells in the Coastal Areas of the Northwest District

COUNTY: SANTA ROSA

Map #	Well Name	I.D. Number	Total Depth	Casing Depth	Altitude
1	West Observation Well	302224086543801	1020	840	10
2	Navarre Beach #1	302244086525201	950	810	7
3	Navarre Beach #2	302259086515701	1051	782	7
4	Navarre Beach #3	302220086530701	1030	925	8
5	East Observation Well	302257086511501	940	730	5
6	Eglin AFB A-15	302329086480901	1088	708	13

COUNTY: OKALOOSA

Map #	Well Name	I.D. Number	Total Depth	Casing Depth	Altitude
7	Eglin AFB A-13	302334086444001	835	654	15
8	Eglin AFB A-11	302342086424801	794	640	8
9	Eglin AFB A-10	302357086415101	822	580	12
10	Eglin AFB A-7	312348086390001	738	538	12
11	Eglin AFB A-6	302351086382901	868	623	12
12	Ok. Isl. Authority #4	302347086360401	736	545	10
13	Ok. Isl. Authority #3	322352086375701	867	528	7
14	Ok. Isl. Authority #2	302346086352401	845	455	5
15	Wayside Park #1	302338086352601	684	462	12
16	Eglin AFB A-3	302334086332901	735	505	15
17	Mrs. Kelly Sims	302347086304201	628	419	15
18	Destin #1	302340086294201	632	415	25
19	Aegean Condo	302303086294501	600	457	5
20	Destin #3	302331086284601	731	450	25
21	Destin #2	302321086275201	634	432	28
22	Destin #4	302409086291101	731	442	15
23	Crystal Beach	302259086253401	710	380	37

COUNTY: WALTON

Map #	Well Name	I.D. Number	Total Depth	Casing Depth	Altitude
24	South Walton #3	302258086250301	554	410	18
25	South Walton #1	302239086213401	662	458	21
26	South Walton #2	302249086203501	595	395	5
27	South Walton #4	302258086225301	554	410	18
28	DNR Cofeen #1	302224086192201	481	---	20
29	West Hewett	302224086171701	697	532	18
30	Don Bishop	302231086154501	365	270	15
31	Dune I	302112086151401	443	321	15
32	St. Rita Catholic Church	302225086141801	333	253	17
33	Sea Bluff	302027086122201	403	283	27
34	Forest Dunes	302025086101101	532	332	21
35	J.A Holley	302231086153201	533	253	12
36	W.L. Mundy	302247086091301	370	215	5
37	USGS Causeway	302357086100701	332	---	5
38	James Kistenson	302357086121401	322	170	6
39	Mathews	302442086130701	325	160	5
40	W.A. Holley	302314086103401	349	157	5
41	Seagrove Beach #3	301885086065501	448	238	22
42	Camp Creek Subdivision	301733086032001	590	246	20
43	Inlet Beach #1	301637086000201	427	94	28
44	Inlet Beach #2	302645086003001	578	231	32

COUNTY: BAY

Map #	Well Name	I.D. Number	Total Depth	Casing Depth	Altitude
45	Camp Helen	301626085592501	460	---	22
46	Panama City Beach #1	301350085532201	724	304	38
47	Panama City Beach #10	301218085493701	699	412	10
48	Panama City Beach #9	301354085524201	759	393	10
49	Panama City Beach #6	301316085520401	698	337	10
50	Panama City Beach #5	---------------	864	348	10
51	Panama City Beach #7	301046085483501	434	292	10
52	Panama City Beach #8	301041085481701	450	286	8

53	US Navy Mine Def. Lab #1	301025085451901	594	246	10
54	US Navy Mine Def. Lab #2	301019085451901	595	250	10
55	US Navy Mine Def. Lab #3	301030085452001	473	250	10
56	Point Royal	300923085445901	525	284	10
57	St. Andrews State Park	300726085441901	384	293	15
58	St. Andrews State Park	300807085440401	380	--	10
59	Tyndall AFB Golf Course	300630085401701	500	324	16
60	Tyndall AFB #6	300453085362101	644	351	31
61	Tyndall AFB #2	300404085351701	653	339	26
62	Tyndall AFB #7	300347085345501	645	345	28
63	Tyndall AFB #3	300358085353901	661	356	24
64	Tyndall AFB #4	300407085355501	435	356	24
65	Tyndall AFB D-2 well	295804085282501	640	--	21
66	Mexico Beach #1	295645085243901	485	412	12
67	Mexico Beach #2	295645085243001	590	190	10

COUNTY: GULF

Map #	Well Name	I.D. Number	Total Depth	Casing Depth	Altitude
68	Port St. Joe #1	294933085180301	653	389	12
69	Port St. Joe #3	294936085175001	656	420	12
70	Lighthouse Util. #1	294120085182701	577	363	3
71	Lighthouse Util. #2		623	422	8
72	St. Joe Spit Test	294253085425301	155	137	16
73	USAF #33 (Eglin AFB)	293958095211801	588	480	7
74	USAF D-3 (Eglin AFB) #1	294032085204501	644	594	10
75	USAF D-3 (Eglin AFB) #2	294042085204301	590	--	10
76	M K Ranch--shop	295650085052201	488	366	12
77	M K Ranch--irrigation	293712085050201	585	233	26

COUNTY: FRANKLIN

Map #	Well Name	I.D. Number	Total Depth	Casing Depth	Altitude
78	Apalachicola #1	294327084585501	--	--	--
79	Apalachicola #2	294350084593101	394	303	15
80	Apalachicola #4	294346084593001	465	330	--

81	Bobby Kirvin	294400084593601	376	285	4
82	McCulloch #1	294339084432401	266	158	7
83	McCulloch #1A	294322084531601	246	163	4
84	McCulloch #3A	294342084531601	404	337	9
85	Leisure Properties #1	294405084531501	263	170	--
86	Alan Hubanks	295055084410301	96	90	7
87	J.F. Kilborn	295046084394301	87	59	5
88	J.C. Rosenau	295150084405201	57	---	8
89	St. Joe Paper	295507084311901	166	72	30
90	Emily Kemp	295536084275301	109	96	--
91	Alligator Point #1	295302084223501	130	--	28

COUNTY: WAKULLA

Map #	Well Name	I.D. Number	Total Depth	Casing Depth	Altitude
92	Georges Motel	295840084225801	132	66	14
93	Town of Panacea	295845084230501	57	40	11
94	Panacea #2	295845084230501	79	42	11
95	Panacea #4	300151084235801	113	78	12
96	Wildlife Refuge test	300148084242801	108	39	14
97	TEC Gulf Coast #1	300618084193801	191	117	14
98	TEC Gulf Coast #2	300618084193801	189	62	14
99	TEC Shell Point #1	300500084182701	178	31	10
100	TEC Shell Point #2	300500084182501	109	96	10
101	Lester Lewis	300540084174001	74	26	9
102	Jerry Wells	300343084171001	48	26	5
103	St. Marks Refuge Hdqrs	300516084094801	54	34	11

APPENDIX B: Major Water Users in Coastal Areas of the Northwest District.

****

COUNTY: BAY

Owner/Address			Location		
Avg. Use/Max. Use	Area	Well	Lat/Long	Quadrangle	Aquifer
U.S. Department of the Navy	A	1	30.11.10/85.08.02	Panama City	Floridan
Naval Coastal Systems Center				Beach	
Panama City, FL 32404					
0.100 Mgal/d/ 0.201 Mgal/d					
Bay Pointe Yacht and Country Club	A	1	30.08.45/85.44.45	Panama City	Floridan
100 Delwood Beach Road					
Panama City Beach, FL 32407					
0.100 Mgal/d/ 0.214 Mgal/d					
Town of Mexico Beach	B	1	29.56.45/85.24.39	Beacon Hill	Floridan
P.O. Box 13425		2	29.56.39/85.24.36	Beacon Hill	
Mexico Beach, FL 32410					
0.300 Mgal/d/ 0.665 Mgal/d					
City of Lynn Haven	A	1	30.14.29/85.38.53	Panama City	Floridan
825 Ohio Avenue		3	30.14.47/85.38.53	Panama City	
Lynn Haven, FL 32444		4	30.14.14/85.38.58	Panama City	
		5	no data	Panama City	
0.880 Mgal/d (est.)					
Lansing Smith Electric Generating Plant	B	1	30.15.58/85.15.58	Southport	Floridan
P.O.Box BG		2	30.15.58/85.15.58	Southport	
Lynn Haven, FL 32401		3	30.15.58/85.15.58	Southport	
0.700 Mgal/d/ 2.900 Mgal/d					

****

COUNTY: FRANKLIN

Owner/Address Avg. Use/Max. Use	Area	Well	Location Lat/Long	Quadrangle	Aquifer
Alligator Point Water Resources District P.O. Box 155 Panacea, FL 32346 0.120 Mgal/d/ 0.417 Mgal/d	A	1 2 3 4 5	29.56.05/84.22.05 29.56.05/84.22.05 29.53.35/84.22.50 29.53.35/84.22.50 29.53.35/84.22.50	Lighthouse Pt Lighthouse Pt Lighthouse Pt St Teresa St Teresa	Floridan
City of Carrabelle P.O. Drawer 569 Carrabelle, FL 32322 0.300 Mgal/d/ 0.631 Mgal/d	B	1 2	29.50.59/84.39.47 29.50.59/84.39.47	Carrabelle Carrabelle	Floridan
Lanark Village Water and Sewer District P.O. Box 710 Lanark Village, FL 32323 0.200 Mgal/d/ 0.400 Mgal/d	B	1 2	29.53.27/84.34.53 29.53.27/84.34.53	McIntyre McIntyre	Floridan
St. George Island Utilities P.O. Box 430 Apalachicola, FL 32320 0.403 Mgal/d/ 1.086 Mgal/d	B	1 2	29.44.05/84.53.15 29.44.11/84.53.11	Apalachicola Apalachicola	Floridan

****

COUNTY: GULF

Owner/Address Avg. Use/Max. Use	Area	Well	Location Lat/Long	Quadrangle	Aquifer
City of Port St. Joe P.O. Box D-A Port St. Joe, FL 32456 0.867 Mgal/d/ 1.300 Mgal/d	B	1 2 3 4	29.49.33/85.17.53 29.49.33/85.17.53 29.49.33/85.17.53 29.49.33/85.17.53	Port St. Joe Port St. Joe Port St. Joe Port St. Joe	Floridan Surf

****

COUNTY: OKALOOSA

Owner/Address Avg. Use/Max. Use	Area	Well	Location Lat/Long	Quadrangle	Aquifer
Destin Water Users	A	1	30.23.56/86.29.46	Destin	Floridan
P.O. Box 308		2	30.23.21/86.27.55	Destin	
Destin, FL 32541		3	30.23.32/86.28.50	Destin	
		4	30.24.10/86.29.13	Destin	
2.440 Mgal/d/ 6.552 Mgal/d		5	30.24.02/86.31.17	Destin	
City of Niceville	B	1	30.31.42/86.29.18	Niceville	Floridan
208 N. Partin Drive		2	30.31.11/86.28.42	Niceville	
Niceville, FL 32578		3	30.31.22/86.27.58	Niceville	
		4	30.32.03/86.30.04	Niceville	
2.152 Mgal/d/ 3.228 Mgal/d		5	30.32.02/86.28.39	Niceville	
		6	30.31.16/86.26.35	Niceville	
Okaloosa County Water and		OC-1	30.28.04/86.35.10	Ft Walton Bch	Floridan
Sewer System		OC-2	30.28.04/86.35.14	Ft Walton Bch	
10 First Avenue		OC-3	30.36.30/86.36.52	Ft Walton Bch	
Fort Walton Beach, FL 32548		OC-4	30.26.31/86.37.48	Mary Esther	
		OC-5	30.36.25/86.34.20	Ft Walton Bch	
4.940 Mgal/d/ 7.770 Mgal/d		OC-6	30.26.35/86.38.29	Mary Esther	
		OC-8	30.27.20/86.38.29	Mary Esther	
		ISL-1	30.23.45/86.35.14	Ft Walton Bch	
		ISL-2	30.23.45/86.35.22	Ft Walton Bch	
		ISL-3	30.23.46/86.35.28	Ft Walton Bch	
		ISL-4	30.23.50/86.35.57	Ft Walton Bch	
		ISL-6	30.23.59/86.37.20	Mary Esther	
Seashore Village Water	B	1	30.24.40/86.43.45	Mary Esther	Floridan
System, Inc.		2	30.24.42/86.47.10	Navarre	
P.O. Box 868		3	30.24.52/86.45.39	Navarre	
Mary Esther, FL 32569					
0.392 Mgal/d/ 0.980 Mgal/d					
City of Valparaiso	B	1	30.30.35/86.30.05	Valparaiso	Floridan
P.O. Box 296		2	30.31.04/86.30.29	Niceville	
Valparaiso, FL 32580		3	30.31.26/86.30.28	Niceville	
0.600 Mgal/d/ 0.892 Mgal/d					

Town of Mary Esther	B	1	30.24.40/86.39.47	Mary Esther	Floridan
195 Cristobal Road		2	30.24.40/86.39.47	Mary Esther	
Mary Esther, FL 32569					
0.650 Mgal/d/ 1.060 Mgal/d					

Northgate Development Company, Inc.	B	1	30.25.32/86.23.52	Mary Esther	Floridan
203 John Simms Parkway					
Niceville, FL 32578					
0.400 Mgal/d/ 6.08 Mgal/d					

City of Fort Walton Beach	B	2	30.25.08/86.36.42	Ft Walton Beach	Floridan
P.O. Box 4009		3	30.25.11/86.38.21	Ft Walton Beach	
Fort Walton Beach, FL 32549		5	30.25.05/86.35.55	Ft Walton Beach	
		6	30.27.30/86.36.48	Ft Walton Beach	
4.322 Mgal/d/ 6.515 Mgal/d		7	30.27.06/86.36.48	Ft Walton Beach	
		8	30.25.13/86.38.40	Mary Esther	
		9	30.25.18/86.39.10	Mary Esther	
		10	30.37.35/86.37.17	Mary Esther	
		11	30.25.21/86.39.59	Mary Esther	
		A	30.27.30/86.36.48	Ft Walton Beach	S&G
		B	30.27.30/86.36.48	Ft Walton Beach	
		C	30.37.35/86.37.17	Mary Esther	
		D	no data		
		E	no data		

Eglin Air Force Base	C	1	30.29.17/86.29.54	Destin	Floridan
Okaloosa County, FL 32542		2	30.29.09/86.30.13	Ft Walton Bch	
		3	30.29.03/86.30.32	Ft Walton Bch	
4.410 Mgal/d/ 9.078 Mgal/d		4	30.29.00/86.30.12	Ft Walton Bch	
		5	30.28.29/86.29.51	Destin	
		6	30.29.03/86.30.17	Ft Walton Bch	
		7	30.28.09/86.32.37	Ft Walton Bch	
		8	30.27.20/86.32.20	Ft Walton Bch	
		9	30.28.01/86.32.06	Ft Walton Bch	
		10	30.27.43/86.33.01	Ft Walton Bch	
		11	30.27.02/86.32.16	Ft Walton Bch	
		12	30.28.49/86.30.09	Ft Walton Bch	
		13	30.27.19/86.32.38	Ft Walton Bch	
		14	30.28.01/86.32.49	Ft Walton Bch	
		15	30.28.42/86.33.19	Ft Walton Bch	
		16	30.27.26/86.33.43	Ft Walton Bch	

****

COUNTY: SANTA ROSA

Owner/Address Avg. Use/Max. Use	Area	Well	Location Lat/Long	 Quadrangle	Aquifer
Pace Water System	B	1	30.36.06/87.09.33	Pace	S&G
P.O. Box 1049		2	30.36.41/87.08.30	Pace	
Pace, FL 32570		3	30.36.15/87.06.51	Milton South	
		4	30.34.16/86.06.00	Pace	
1.700 Mgal/d/ 3.300 Mgal/d		5	30.36.51/87.06.46	Milton South	
Midway Water System	B	1	30.24.17/86.52.15	Navarre	Floridan
P.O. Box 70		2	30.25.55/86.54.08	Holley	
Gulf Breeze, FL 32561					
3.000 Mgal/d/ 3.344 Mgal/d					
Santa Rosa Shores Utilities	A	3	30.23.00/87.05.11	Garcon Point	S&G
P.O. Box 400		4	30.22.57/87.05.11	Garcon Point	
Gulf Breeze, FL 32561		5	30.23.00/87.05.17	Garcon Point	
0.400 Mgal/d/ 0.700 Mgal/d					
Holley-Navarre Water System		1	30.25.50/86.51.45	Holley	Floridan
P.O. Box 837		2	30.26.50/86.52.00	Holley	
Gulf Breeze, FL 32561					
1.500 Mgal/d/ 2.304 Mgal/d					
Air Products and Chemicals		1	30.35.26/87.07.48	Pace	S&G
P.O. Box 467		2	30.35.24/87.08.05	Pace	
Pensacola, FL 32592		3	30.34.46/87.08.20	Pace	
		5	30.35.28/87.07.33	Pace	
4.320 Mgal/d/ 7.200 Mgal/d		6	30.35.26/87.08.22	Pace	
American Cyanamid Company	B	2	30.34.20/87.07.18	Milton South	S&G
1801 Cyanamid Road		3	30.34.07/87.07.05	Milton South	
Milton, FL 32570		4	30.34.04/87.06.50	Milton South	
		5	30.34.06/87.06.28	Milton South	
4.845 Mgal/d/ 6.970 Mgal/d		6	30.34.35/87.06.50	Milton South	

Santa Rosa Board of Commissioners	A	1	30.22.15/86.52.45	Holley	Floridan
Navarre Beach Utility System		2	30.22.54/86.52.13	Navarre	
		3	30.22.20/86.53.07	Holley	

0.400 Mgal/d/ 0.800 Mgal/d

****

COUNTY: WAKULLA

Owner/Address Avg. Use/Max. Use	Area	Well	Location Lat/Long	Quadrangle	Aquifer
Talquin Electric Cooperative	B	51	30.06.08/84.17.30	Spring Creek	Floridan
Gulf Coast System		52	30.06.08/84.17.30	Spring Creek	
P.O. Box 191					
Quincy, FL 32351					

0.247 Mgal/d/ 0.460 Mgal/d

Panacea Area Water System	A	2	29.58.45/84.23.05	St Teresa	Floridan
P.O. Box 215		3	30.01.47/84.24.15	St Teresa	
Panacea, FL		4	30.01.51/84.23.50	St Teresa	
		5	30.01.48/84.24.28	St Teresa	

0.130 Mgal/d (est.)

****

COUNTY: WALTON

Owner/Address Avg. Use/Max. Use	Area	Well	Location Lat/Long	Quadrangle	Aquifer
South Walton Utility Company, Inc.	A	1	30.22.42/86.21.04	Choctaw Bch	Floridan
Box 355, Star Route		2	30.22.49/86.20.30	Choctaw Beach	
Destin, FL 32541		3	30.22.45/86.19.45	Choctaw Beach	
		4	30.22.41/86.19.42	Miramar Beach	

2.150 Mgal/d/3.737 Mgal/d

Seascape Resort P.O. Box 970 Destin, FL 32541 0.500 Mgal/d/ 1.000 Mgal/d	A	1 2	30.22.45/86.22.12 30.22.44/86.22.50	Destin Destin	Floridan
John V. Smith Water Company Seagrove Beach Water System 234 Deer Avenue Niceville, FL 32578 0.120 Mgal/d/ 0.458 Mgal/d	A	1 2 3	30.19.04/86.07.37 30.19.02/86.07.32 30.19.00/86.06.56	Grayton Beach Grayton Beach Pt Washington	Floridan
Santa Rosa Golf and Beach Club, Inc. Highway 30A Santa Rosa Beach, FL 32459 0.148 Mgal/d/ 0.210 Mgal/d	A	1 2 3	30.21.50/86.14.00 30.21.50/86.14.00 30.21.50/86.14.00	Grayton Beach Grayton Beach Grayton Beach	Floridan S&G
City of Freeport P.O. Box 339 Freeport, FL 32439 0.320 Mgal/d/ 0.347 Mgal/d	B	1	30.29.15/86.07.20	Freeport	Floridan